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Safety in the Science Classroom

Consultation Draft

November 2004

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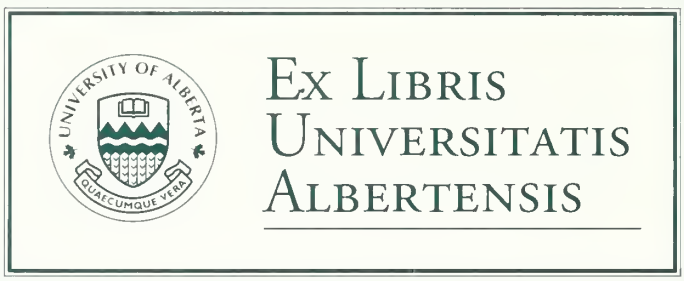

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The materials in this safety resource have been compiled from sources believed to be reliable and accurate; and to represent the best of current thinking on the subject. This resource is intended to serve as a starting point for planning good practices, but does not purport to specify the level of technical detail that some users may require, or to have anticipated every circumstance where safety may be a factor.

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Introduction

Experiments are a fundamental part of student learning in science. In early grade levels, exploratory activities provide the starting point for concept and skill development. In later grades, students deepen their scientific understanding and enhance their problem-solving and scientific-inquiry skills through more controlled investigations. One of the challenges in teaching science is to offer students hands-on activities that are both educationally rewarding and safe. This challenge is shared by everyone involved: those who plan and deliver science programs, those who design and maintain the learning environment, and those who select and prepare the materials used.

The goal of this science safety resource is to bring together information from a variety of sources in order to give science teachers, administrators and support staff a handy reference that will help them make sound decisions regarding science safety. The resource identifies a variety of safety concerns and suggests effective ways to eliminate or minimize them. It also identifies and summarizes legislative regulations that govern facility design, emergency preparedness, staff training, and the management, use and disposal of chemicals.

Knowing about possible hazards and taking precautions are the basis of a safe learning environment in science. It is hoped that this document will provide much of the information needed to ensure that such a safe learning environment continues to prevail in science classes and laboratories in Alberta schools.

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Part A: General Safety Management

Chapter 1:
Starting Points for Planning and Policy Setting

OVERVIEW

This chapter sets the stage for safety planning for science classrooms. The chapter outlines the roles of key stakeholders, and lists sample actions that are appropriate to these roles. It also summarizes legislative requirements that impact on planning for science safety. Finally, it provides general guidelines for promoting safety.

DUE DILIGENCE: an approach to science safety

A first step in planning for science safety is to become aware of the potential hazards that science activities may present. Further steps focus on minimizing risks by taking reasonable safety precautions—in other words, by acting with due diligence.

In a legal context, due diligence means taking all reasonable steps to prevent accidents and injuries, and thus avoid assuming legal liability. However, due diligence is more than just a legal concept; it is a positive approach to avoiding accidents and injuries by identifying possible hazards, planning precautionary actions, and fulfilling one's responsibilities. This more general definition provides a common sense starting point for safety planning.

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Principals, administrators, teachers and other staff can demonstrate due diligence by taking action in the following three key areas:

- ensuring awareness of potential risks and the related safety regulations
- ensuring staff competency in meeting these regulations, thereby avoiding unnecessary risk
- implementing monitoring and compliance strategies to ensure that regulations are met.

Awareness of Legislated Safety Requirements

Principals, administrators, teachers and other personnel need to know about a number of legislative regulations designed to protect students, staff members, the public and the environment. It is important to know about these regulations not only because they are legal obligations, but also because they help educators to better understand potential risks and the preventative measures that can be taken. Relevant legislation and requirements are summarized in this chapter as they relate to safe practices in the science classroom. For further details, please refer directly to the acts, regulations and codes on which the summaries are based. Current URLs for these documents are included in the summaries.

Staff Competency

As outlined in section 8 of The Alberta Teachers' Association (ATA) Code of Professional Conduct and section 13 of the Occupational Health and Safety regulation, it is essential that teachers and other staff who perform potentially dangerous tasks are competent to handle these tasks. Competency means being aware of risks and properly trained in relevant procedures. One of the legal responsibilities of administrators is to develop and implement plans to give staff this knowledge and training.

Evidence of staff competency may be required by provincial inspectors or investigators. For example, if a teacher was burned while handling chemicals in a science preparation area, a provincial investigator would determine whether the teacher:

- had received Workplace Hazardous Materials Information System (WHMIS) training
- knew where information on the chemicals was available
- knew how to use the appropriate safety equipment.

If the investigator found that the teacher was not competent to handle the chemicals, his or her employer could be held liable and charged under the Alberta Occupational Health and Safety legislation.

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Monitoring and Compliance

The third area of due diligence involves monitoring work environments and activities to ensure compliance with health and safety legislation. For principals and administrators, this means monitoring their schools or work sites to make sure that staff comply with legislation and work in a safe and healthy manner. For teachers and other staff, it means identifying and following safe procedures, and reporting situations that create potential risks.

Monitoring and compliance can be supported by:

- discussing health and safety, regularly, at staff meetings
- reviewing, periodically, plans, practices and responsibilities related to science safety
- developing processes to keep staff aware of changes in legislation
- communicating regularly and sharing information on safety issues (for example, if an individual encounters a problem with a piece of equipment, he or she makes others in the school and district aware of the problem)
- evaluating unusual activities for safety considerations, and dealing with any health and safety issues before the activity begins
- reporting any violations of legislative requirements or district policy, using appropriate procedures
- giving regular attention to the following areas in planning:
  - Emergency preparedness. Are plans updated as required to reflect changes, e.g., are students' home phone numbers current? Are drills conducted regularly?
  - Hazard identification and control. Are hazards identified, evaluated and dealt with appropriately? Are inspections conducted regularly? Are recommendations dealt with promptly?
  - Accident/incident reporting and investigation. Are all accidents reported to appropriate authorities as required? Has a near-miss incident-reporting system been set up and is it working effectively? Have incident statistics been analyzed and are appropriate actions being taken in response?
  - Environmental protection. Are all releases (leaks or spills) being reported? Is hazardous waste being properly identified, stored and disposed of from the school?
  - Safe work practices. Are safe operating procedures in place or being developed for hazardous activities? Are staff trained in these procedures? Are Material Safety Data Sheets accessible to staff in electronic or hard copy format?
  - Training. Are all new staff given safety orientation training? Are existing staff members trained as necessary? Are training records kept?

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KEY PLAYERS: roles and sample actions

Responsibility for ensuring safety in the science classroom is shared by many members of the educational system, including:

- Alberta Learning
- School boards and superintendents
- School administrators
- Science teachers
- Science technicians and other school staff
- Science students
- Parents
- Volunteers

Individuals in each of these groups have specific roles to play in promoting safety in the science classroom. These roles, as well as some of the possible actions that go along with each role, are described below. However, these tasks may vary depending on the situation and will frequently overlap. It is up to everyone involved to work together as a team to ensure that responsibilities are determined, understood and fulfilled.

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Role: Make safety information available to Alberta schools.

Sample Actions:

- Develop and/or authorize resources that offer information and guidelines on safety in science classrooms and laboratories.
- Update, periodically, authorized science safety resources.
- Provide information sessions to highlight safety roles, strategies and resources.

School Boards and Superintendents

Role: Provide leadership and resources to support science safety.

Sample Actions:

- Initiate planning for the safety of students and staff.
- Develop safety policies consistent with regulations and codes, and facilitate the implementation of these policies.
- Request and/or direct safety and health investigations.
- Ensure that school and district staff carry out their safety responsibilities.
- Provide training and support to ensure staff competency.

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- Make staffing assignments that permit safe operation and maintenance of science facilities on a day-to-day basis, for example through the assignment of science department heads or laboratory aides.
- Ensure that each school has staff trained in first aid and emergency care.
- Make provisions for the safety of students with special needs or language difficulties.
- Establish a system to monitor the effectiveness of safety policies and practices in their schools.

School Administrators

Role: Ensure safe policies and practices are in place at the school level, and support teachers in providing a safe working environment.

Sample Actions:

- Ensure that staff have the safety training and expertise they need.
  - Ensure that teachers and substitute/supply teachers of science have the expertise to safely teach the assigned curriculum.
  - Ensure that staff who handle hazardous materials and prepare laboratories have the expertise to do so.
  - Enable teachers and technicians to obtain training in science safety, in particular to meet the requirements of the Workplace Hazardous Materials Information System (WHMIS) and the *Transportation of Dangerous Goods (TDG) Act*
- Give consideration, in setting policies and practices for school organization, to:
  - the numbers of students per science class
  - classroom size and facilities
  - curricular requirements.
- Provide for the safety of students with special needs or language difficulties.
- Ensure that all facilities used for science activities are safe and appropriate for the kinds of activities carried out in them, and that necessary safety equipment is available.
- Ensure that procedures are in place for hazard reporting, and that all safety concerns regarding facilities, equipment and procedures are addressed.
- Ensure that schools have effective policies and procedures to follow in case of accidents and emergencies.
- Maintain accurate records of accidents and treatments provided, and report accidents as required. Also document near misses.
- Implement and maintain safe storage and waste-disposal systems for hazardous substances used or produced in the school.

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- Cooperate with outside personnel and agencies in promoting science safety (e.g., local Fire Marshal, Occupational Health and Safety, Alberta Environment).
- Stop any practices that jeopardize student or staff safety.
- Support disciplinary measures that the teacher may take to ensure safety in science classes.
- Ensure the school follows safety regulations and procedures.

Science Teachers

Role: Advocate and model safe practices in the science classroom/ laboratory.

Sample Actions:

- Implement safety regulations specified by Board policy and relevant legislation.
- Make prudent decisions regarding the selection of laboratory activities, taking into account the learning environment, the knowledge and skills of the students, and the teacher's knowledge, expertise and training to conduct activities in a safe and effective manner.
- Contribute to developing and implementing a lab safety policy.
- Provide safety guidelines or lessons to students at the beginning of each year or course. Outline students' roles and actions in maintaining classroom safety, and the location and use of safety equipment. Where appropriate, obtain written confirmation from students that these responsibilities are understood and accepted. See Appendix B for a sample Safety Contract for elementary students and Appendix C for secondary students.
- Explain and model safety procedures for each learning activity.
- Monitor students and correct behaviour that jeopardizes safety.
- Maintain a list of students with allergies, contact lenses, other corrective medical devices and special needs (e.g., hearing impairment). Use a "buddy" system or other system for those with special needs.
- Be familiar with the location and use of safety equipment and the location of main gas valves and electrical breakers.
- Report any defects in science equipment, facilities or practices to the school administrator responsible for safety.
- Report, verbally, any injuries or accidents to the school principal immediately, followed by a written report. Document near-misses.
- Participate in health and safety training provided by the employer.
- Inform administration when work conditions or responsibilities have changed and additional training is required.
- Take on any roles and responsibilities of a science technician that have not been designated to someone else. If this includes

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shipping and receiving chemicals, Transportation of Dangerous Goods (TDG) training is required.

Science Technicians

Role: Assist in promoting and maintaining safety standards in laboratory and classroom activities, manage chemical inventories in accordance with WHMIS and other regulations, and ensure all science and safety equipment is in good repair.

Sample Actions:

- Maintain laboratory safety equipment and ensure it is accessible.
- Ensure all science equipment is in good working condition.
- Identify, document and inform teachers of safety problems related to specific lab activities, and adapt activities when necessary to eliminate problems while still meeting curriculum needs.
- Follow WHMIS and TDG regulations when dealing with chemicals and waste.
- Conduct a yearly chemical inventory, ensuring Material Safety Data Sheets are current, and submit the inventory to the school's designated person responsible for hazardous materials.
- Work with the science curriculum leader to promote safe procedures and maintain safety standards in all science activities.
- Keep safety in the forefront within the science department through meetings, articles, posters or other methods.

Science Students

Role: Support safety in the science classroom by acting responsibly and knowing how to respond to unsafe situations and emergencies.

Sample Actions:

- Inform the teacher of health concerns and circumstances that could affect personal safety, e.g., allergies, medications, use of contact lenses.
- Come to the laboratory appropriately dressed for lab work, e.g., closed shoes, long hair tied back, no loose clothing or jewellery.
- Wear goggles and an apron, or use other safety equipment as required.
- Learn about the hazards posed by materials and equipment to be used in each activity.
- Learn safe procedures to use in each activity and procedures to be avoided.
- Learn about the location and use of safety equipment.
- Follow all safety procedures and instructions, and act in a way that shows concern for their own safety and the safety of others.

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- Begin activities only with the teachers' permission.
- Report unsafe situations or accidents to the teacher immediately.
- Dispose of all chemicals, specimens and other materials as instructed by the teacher.
- Wash hands thoroughly after each experiment.

Parents

Role: Support the school's efforts to provide safety in the classroom or laboratory.

Sample Actions:
- Inform the school about relevant student medical problems.

Volunteers

Role: Support the classroom teacher in maintaining safety.

Sample Actions:
- Find out about the hazards posed by materials and equipment to be used in science activities.
- Learn safe procedures to use in each activity and procedures to be avoided.
- Understand and model safe behaviour.
- Monitor equipment and student behaviour, and report any unsafe conditions to the teacher.

LEGISLATIVE REQUIREMENTS

Legislative requirements relevant to science safety are found in the following sources (listed in alphabetical order):

- *Alberta Building Code*
- *Alberta Environmental Protection and Enhancement Act (AEPEA) and Regulations*
  - Waste Control Regulation
- *Alberta Fire Code*
- *Environmental Protection Act (Canada)*
- *Hazardous Products Act*
- *Labour Relations Code*

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- *Occupational Health and Safety Act, Regulations and Code*
  - Chemical Hazards, Biological Hazards and Harmful Substances
  - Emergency Preparedness and Response
  - First Aid
  - Workplace Hazardous Materials Information System (WHMIS)
- *School Act and Regulations*
- *Teaching Profession Act*
- *Transportation of Dangerous Goods (TDG) Act and Regulations*
- *Canada Water Act*

Many aspects of school safety are governed by more than one piece of legislation. For example, the use of chemicals in schools is regulated under the *Occupational Health and Safety Code*, the *Hazardous Products Act*, the *Transportation of Dangerous Goods Act and Regulations* and the *Alberta Environmental Protection and Enhancement Act*. Additional aspects of chemical safety are regulated by the Waste Control Regulation and the *Water Act*, and may be further regulated by municipal sewer and solid waste bylaws.

Highlights of Legislated Safety Regulations

The following sections highlight some important elements of key legislation as they relate to science safety, and outline how teachers, administrators and other staff can meet these requirements.

Alberta Building Code:

The *Alberta Building Code* describes safety features that must be built into a structure to ensure specific levels of safety, including standards for electrical wiring, fire alarm systems, emergency routes, lighting and ventilation (including the venting of chemical storage areas). As well, the code specifies an occupation load for floor areas, including classrooms ($0.75m^2$/student) and laboratories ($4.6m^2$/student). This code includes certain regulations that are also set out in the *Alberta Fire Code*—for example, the requirement of an emergency or second exit from science classrooms or laboratories.

Environmental Protection and Enhancement Act (Alberta):

- The AEPEA was established to help protect and improve the environment. The act is essentially preventive in nature: it ensures that potentially damaging activities can proceed only if their impact has been closely examined and provisions have been made to adequately protect the environment against damage. Approval licenses typically stipulate ongoing reporting on

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groundwater quality and air emissions. The act also states that all polluters—including schools—are expected to pay for the cost of their actions if any potentially damaging substance is released into the environment:

- the release must be reported immediately
- immediate steps must be taken to confine, clean up and dispose of the substance
- the environment must be returned to a condition that is satisfactory to Alberta Environmental Protection.

The full text of the *Environmental Protection and Enhancement Act* can be viewed at http://www.qp.gov.ab.ca/documents/Acts/E12.cfm?frm_isbn=0779727215.

Waste Control Regulation (Alberta):

- This regulation sets out requirements for handling, storing and disposing of hazardous wastes generated by industry or institutions, including schools or school districts, and stipulates how to deal with hazardous waste spills. Although specific waste products are not identified by name, the regulation describes the properties that determine whether waste materials can be disposed of in landfills.

  The full text of the *Water Control Regulation* can be viewed at http://www.qp.gov.ab.ca/documents/Regs/1996_192.cfm?frm_isbn=0779723341.

Alberta Fire Code:

This legislation outlines acceptable building materials and design to meet specific fire safety limits, particularly in areas where there is a higher potential for fire or explosions, such as school laboratories and chemical storage areas. It specifies requirements for storage of combustible or dangerous substances (including arrangement, labelling and venting), chemical spill control, fire safety plans, emergency procedures, fire drills and fire department access. As well, it provides guidelines for fire protection equipment, including extinguishing systems, extinguishers, water supply systems, fire alarm systems and emergency power installations.

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Environmental Protection Act (Canada):

The *Environmental Protection Act (Canada)* is the federal equivalent of the AEPEA. The act and its regulations describe procedures for storage, transport and disposal of hazardous wastes produced by industries as well as schools or school districts, and outlines how to deal with spills. Like the AEPEA, this act states that all polluters are expected to pay for the cost of their actions.

The full text of the *Environmental Protection and Enhancement Act* can be viewed at http://laws.justice.gc.ca/en/C-15.31/fulltoc.html.

Hazardous Products Act (Canada):

This act defines what materials are designated as *Controlled Products* in Canada. Designation of *controlled products* has the following significance for schools:

- The Workplace Hazardous Materials Information System (WHMIS) requirements apply to all materials designated as *controlled products*. Suppliers of *controlled products* are required to provide a Material Safety Data Sheet (MSDS) for each product, and to make sure the product or its container is labelled with required information and hazard symbols.
- The advertising, sale and importation of *controlled products* for use in the workplace, including Canadian schools, is regulated under the act.

The full text of the *Hazardous Products Act* can be viewed at http://www.cbsa-asfc.gc.ca/E/pub/cm/d19-5-1/d19-5-1-e.pdf.

Labour Relations Code:

In cases of a Labour Board inquiry into employment conditions, this code gives the board or an officer of the board the right to inspect the school premises, question employees and examine school records relating to safety inspections, fire drills and staff training programs.

The full text of the *Labour Relations Code* can be viewed at http://www.qp.gov.ab.ca/documents/acts/L01.cfm.

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Occupational Health and Safety Act, Regulations and Code:

The *Occupational Health and Safety Act, Regulations and Code* was established to ensure reasonable levels of safety in the workplace. It deals with chemical hazards and harmful substances, hazard assessment, first aid, emergency preparedness, fire and explosion hazards, personal protective equipment and ventilation.

This act has extensive implications for both employers and employees (Alberta Justice does not consider students to be workers under this legislation except for those in registered apprenticeship or off-campus work experience programs).

According to the act:

- the employer is responsible for the health, safety and welfare of workers on the job
- the employer must provide information on hazards and their control, and establish an occupational health and safety program
- employees must take steps to protect their own health and safety, and the health and safety of co-workers
- employees have rights under the act to:
  - know about workplace hazards
  - participate in health and safety activities
  - refuse "work that may endanger the worker or others"
- suppliers must ensure that the biological or chemical products they supply are safe for use in the workplace when used according to the instructions they provide.

The full text of the *Occupational Health and Safety Act* can be viewed at http://www.qp.gov.ab.ca/documents/Acts/O02.cfm?frm_isbn=0779714946.

The following sections of the *Occupational Health and Safety Code* are particularly relevant for science classrooms.

Chemical Hazards, Biological Hazards and Harmful Substances:

- give occupational exposure limits for a variety of chemical substances for periods of 15 minutes and 8 hours
- describe the employer's obligations if a worker is exposed to a harmful substance
- provide specific procedures for treating overexposure or contamination
- prohibit eating, drinking and smoking in areas contaminated by a harmful substance.

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Emergency Preparedness and Response:

- states that employers must develop emergency response plans
- outlines the minimum requirements of such a plan, the need for updating the plan and the importance of employee training.

First Aid:

- requires the employer to maintain first aid equipment and supplies and a first aid room
- specifies contents of first aid kits for low-, medium- and high-hazard sites
- states that kits must be clearly labelled so that every worker knows their location.

The Workplace Hazardous Materials Information System (WHMIS):

- outlines a system to inform people of the hazards of materials they might be handling in the workplace and minimize risks
- provides information for controlled or regulated chemicals with higher inherent risks
- specifies standards for:
  - labelling of chemicals: labels alerting the user to hazards of the product and precautions for safe use are mandatory for controlled products
  - material safety data sheets (MSDSs): these sheets provide extensive information about the product, including potential hazards, health effects, proper handling and disposal, and by law must be provided by the supplier with any substance covered under WHMIS
  - WHMIS training and education: knowledge about potential hazards and safety procedures is mandatory for employees working with or near controlled products.

See Chapters 4 and 9 of this document for additional details on WHMIS and MSDSs, and Chapter 9 for details on labelling of chemicals. See Appendix H for agents or consultants that provide WHMIS training in your area, or access an approved computer learning package such as *WHMIS and You* for in-school training and/or review.

The full text of the *Occupational Health and Safety Code* can be viewed at http://www3.gov.ab.ca/hre/whs/publications/pdf/ohsc-1.pdf.

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School Act (Alberta):

In general, this act makes provisions for the safety of students in schools. It also indicates that each individual who is part of the school system—from student to trustee—plays a role in ensuring a safe environment through their due diligence.

The full text of the *School Act* can be viewed at http://www.qp.gov.ab.ca/documents/Acts/S03.cfm?frm_isbn=077973212X.

Teaching Profession Act:

Much like the *School Act*, this act describes teachers' responsibilities for student safety while in the classroom or on off-site school trips.

The full text of the *Teaching Profession Act* can be viewed at http://www.qp.gov.ab.ca/documents/Acts/T02.cfm?frm_isbn=0779732332.

Transportation of Dangerous Goods Act and Regulations:

The *Transportation of Dangerous Goods* (TDG) *Act and Regulations* protects the general public and the environment during the transport of hazardous goods, including regulated chemicals ordered or disposed of by schools. TDG provides a complementary system to WHMIS: during transportation, these products are called dangerous goods and are governed by regulations of TDG; once the dangerous goods have been unloaded from the transport vehicle and received, they become controlled products and fall under WHMIS. The TDG act states that during transport, dangerous goods must be identified by:

- labels on containers
- placards on trucks, and
- shipping documents.

This information is important to staff and others in emergencies, as well as in routine activities. The TDG chemical classifications used in these labels and documents are international in scope, and as a result they are rigidly specified.

The full text of the *Transportation of Dangerous Goods Act* can be viewed at http://laws.justice.gc.ca/en/T-19.01/fulltoc.html.

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Canada Water Act:

This act defines "waste" as substances that alter water quality to the extent that its use would be detrimental to humans, animals, fish, or to plants that are useful to humans. It prohibits pollution of water in areas designated for restoring, maintaining or improving water quality, and specifies the penalties for doing so.

The full text of the *Canada Water Act* can be viewed at http://laws.justice.gc.ca/en/C-11/24944.html.

Local Bylaws

Municipalities, towns and cities generally set out their own by-laws related to waste management and disposal, particularly disposal of substances classified as hazardous, prohibited or restricted. In most cases, local by-laws support and reinforce the regulations of federal and provincial legislation, but they may also provide more specific disposal limits or other details.

For example, in the City of Edmonton, the *Sewers Use Bylaw* states that no person shall release or permit the release of any matter containing a hazardous waste into a sanitary sewer. It also states that a small quantity of wastewater containing a prohibited or restricted waste may be released with prior permission of the City Manager, and only if it is determined to have a minimal adverse effect on the sewage system. The by-law also lists wastes that cannot be disposed via the drain. Similarly, the City of Calgary's by-law prohibits or limits waste disposal through drains, e.g., the by-law limits the concentration of phosphates, sulfates and nitrates disposed through drains.

For further information on prohibited and restricted sewer wastes, see:

- Schedule A of the City of Calgary Sewer Service Bylaw (Bylaw 24M96) at http://www.calgary.ca/docgallery/bu/cityclerks/24m96.pdf.
- Schedule A and B of the Sewer Use Bylaw (Bylaw 9675) at http://www.edmonton.ca/portal/server.pt/gateway/PTARGS_0_2_104_0_0_35/http%3B/cmsserver/NR/rdonlyres/F1757CB1-FF1D-4043-99BB-8FAAA05E77AC/16471/C9675.doc.
- For other areas of the province, check with your municipal office or town/city council for relevant by-laws in your area.

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IMPLEMENTING SAFETY in the science classroom or laboratory

The remaining chapters in this document outline guidelines for emergency preparedness planning, facility design and safety equipment, and minimizing various kinds of risks. To begin implementing science safety, the following key actions can be taken at the classroom, school and divisional levels.

- Establish and document clear safety policies and procedures.
- Designate roles for ensuring safety at the district and school level.
- Involve staff and students in promoting safety.
- Provide ongoing training in health and safety procedures.
- Assess safety in the context of class size, classroom space and adequacy of supervision.
- Conduct a chemical inventory and perform a safety audit for each science classroom/laboratory on a regular basis.
- Ensure that standardized ordering and disposal procedures for chemicals are used.
- Set up and maintain a labelling/dating system, including the provision of an MSDS for each hazardous material.
- Remove, regularly, unnecessary or unsafe materials and waste.
- Obtain and maintain necessary safety equipment, materials and protective clothing.
- Communicate information on issues related to health and safety.
- Monitor and regularly audit the learning environment and activities to ensure that safety policies and procedures are followed.
- Investigate and report accidents and "near-misses."

Elementary Schools

Elementary students thrive on hands-on activities. The opportunity to explore and investigate real materials is a powerful motivator for learning and provides starting points for concept and skill development. The benefits of hands-on activities are well known to teachers, who regularly incorporate them into their programs, taking care to ensure student safety. Steps taken to ensure student safety involve all stages of planning, preparation, supervision and activity follow-up. Example strategies for ensuring safety in elementary science activities are described below, beginning with the early stages of planning.

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Selecting Activities and Materials:

- Consult teacher guides and safety resources to become familiar with risks posed by the activities and materials under consideration.
- Access and review information on student allergies and health conditions that could limit their involvement in science activities.
- Select activities and materials taking into account:
  - potential hazards
  - the knowledge, skills and maturity of the students
  - the equipment and facilities available to safely carry out the activity.
- Do not bring poisonous plants or wild animals—dead or alive—into the classroom, and do not engage in direct investigations of human body tissues and fluids.

Preparing Activities:

- Obtain and prepare safety supplies (e.g., obtain personal equipment such as goggles and gloves)
- Prepare materials for safe use (e.g., prepare dilute solutions in advance, organize materials to facilitate safe distribution)
- Prepare for clean-up and disposal of chemicals and other waste products (e.g., label waste containers).

Introducing and Guiding Activities:

- Involve students in preparing the classroom for safe activity by clearing work surfaces and aisles.
- Introduce equipment and supplies to be used, and how they can be used safely. Identify procedures to follow and actions to avoid.
- Ensure that all students are aware of risks inherent in the materials to be used.
- Initiate short, simple tasks that provide opportunity for students to practise safe procedures before moving on to more complex tasks.
- Model safety at all times.

Follow-up Procedures:

- Have students clean up their workspace, following safe and environmentally responsible procedures.
- Have students wash their hands after taking part in activities that involve chemical or biological materials.

Junior and Senior High Schools

As at earlier levels, activities with real materials can be powerful motivators for learning and provide starting points for concept and skill development. At the junior and senior high levels, experience with materials also provides opportunities to learn about the nature of science investigation and to critically examine the link between

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evidence and theory. With the increasing complexity of concepts studied, investigations may involve more complex equipment and a broader range of materials than studied at the elementary level, creating new challenges for ensuring student safety.

The general strategies for ensuring science safety nevertheless have much in common with earlier levels, involving all stages of planning, preparations, supervision and activity follow-up. The following general strategies are thus recommended. It is further recommended that secondary schools refine and extend these to use as school-specific policies and practices that reflect the program, student characteristics, facilities and staff roles within the school.

Selecting Activities and Materials:

- Consult teacher guides and safety resources to become familiar with risks posed by the activities and materials under consideration.
- Access and review information on student allergies and health conditions that could limit their involvement in science activities.
- Select activities and materials taking into account:
  - potential hazards
  - the knowledge, skills and maturity of the students
  - the equipment and facilities available to safely carry out the activity.
- Avoid bringing poisonous plants or wild animals—dead or alive—into the classroom, and do not engage in direct investigations of human body tissues and fluids.

Preparing Activities:

- Obtain and prepare safety supplies (e.g., obtain personal equipment such as goggles, aprons and gloves).
- Prepare materials for safe use (e.g., prepare dilute solutions in advance, organize materials to facilitate safe distribution).
- Prepare for clean-up and disposal of chemicals and other waste products (e.g., label waste containers).

Introducing and Guiding Activities:

- Set standards for safety preparation and behaviour in laboratories.
- Introduce MSDS symbols, data sheets and safety procedures, and ensure that students understand the need for and application of these standards.
- Provide a general introduction to risks and safety procedures at the outset of the course. In this introduction, review procedures for:
  - handling medical emergencies and accidents
  - handling chemical wastes and spills
  - reporting defective equipment and potential hazards.

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- Familiarize students with the location and use of safety equipment (e.g., eyewash stations).
- Introduce equipment and supplies to be used in each activity, and describe how they can be used safely. Identify procedures to follow and actions to avoid.
- Ensure that all students are aware of risks inherent in the materials to be used.
- Ensure that students use personal protective equipment as required for the activity.
- Provide opportunity for students to practise safe procedures.
- Model safety at all times.
- Consider having students sign a safety contract as a commitment to safety. Retain the contract but recognize that this is not a legal document. See Appendices B and C for sample contracts.

Follow-up Procedures:

- Have students clean up their workspace, following safe and environmentally responsible procedures.
- Have students wash their hands after taking part in activities that involve use of chemical or biological materials.

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Chapter 2
Emergency Preparedness and Response

OVERVIEW

This chapter provides information and strategies to help schools develop and evaluate an emergency preparedness plan, as well as guidelines for and responding to specific emergency situations. Finally, it gives an overview of the benefits of and processes for accident and near-miss reporting.

GENERAL SAFETY AUDIT

A general safety inspection can be a good starting point for preparing to deal with emergencies that are more likely to occur in or impact science classrooms. Typically this inspection would be done as part of the larger school emergency planning process, and would include a thorough evaluation of general safety concerns such as fire prevention and response, as well as response to medical emergencies, gas leaks and other situations. In addition, special attention would be given to areas where chemicals are stored and used, since extra precautions and equipment are involved here.

EMERGENCY PREPAREDNESS PLANNING

Under the *Occupational Health and Safety Code,* every workplace, including schools, must develop and implement an onsite emergency preparedness or response plan. Such a plan establishes procedures to deal with different kinds of emergencies. Any emergency that threatened the safety of students or staff would then be dealt with according to this plan.

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Considerations in Emergency Preparedness Planning

Emergency plans address a number of different safety hazards and emergency situations. At a minimum, the plan would include the following:

- safety measures for fire, including prevention measures specified in the *Alberta Fire Code,* district regulations or elsewhere, and procedures to follow in the event of a fire in a science laboratory or elsewhere
- a building floor plan showing where all toxic substances are located
- procedures for dealing with the release or spill of toxic substances
- procedures for responding to a natural gas or propane leak
- procedures for responding to accidents and medical emergencies
- plans to ensure staff receive adequate orientation and training.

Model Emergency Plan

As they develop or review their plans, schools may find it useful to consult the *School Disaster Planning Model* developed by Emergency Management Alberta, a branch of Alberta Municipal Affairs, in collaboration with stakeholders. This model plan follows generally accepted planning design principles, and is intended as a guideline to help school disaster planners develop, implement, assess and revise their emergency plans. Emergency Management Alberta staff are available to assist with interpreting and applying the plan, taking into account each school or board's unique resources. Staff can also assist with reviewing drafts and evaluating existing plans.

The model plan is divided into four sections.

1. The General Plan

This section outlines the purpose of the plan, the individuals responsible for various components, the general policies that apply to the plan and the procedures that will activate it. The plan itself is divided into three parts: school evacuation, reception of evacuees and offsite emergencies.

2. Check Sheets

These sheets outline the actions that should be taken when the plan is activated. These actions are listed in order of priority and can be used to assign key roles to individuals.

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3. Appendices

The appendices contain the working documents that supplement the procedures defined in the Check Sheets.

4. References

This section provides a list of other resources that would be useful in designing an emergency plan.

The model plan is reviewed annually, with ongoing design and development based on continuous input from school board personnel throughout Alberta and observations made following responses to disasters and mock exercises. You can view and download a copy of model emergency plans for school districts and for schools, by going to the Emergency Management Alberta Web site at http://www.municipalaffairs.gov.ab.ca/ema/emerg_plans.cfm.

Evaluating Your Emergency Planning

To evaluate whether your emergency preparedness planning is adequate, consider whether your plan is realistic, comprehensive and appropriate for the workplace and includes measures for implementation. With effective emergency planning:

- all potential emergencies are addressed in the plan
- the required supplies and equipment (e.g., fire extinguishers, respirators, first aid kit) are available and in good condition
- there is an effective process to communicate a state of emergency
- drills are carried out periodically
- records and evaluation of drills indicate that the plan is feasible
- staff members understand the plan
- staff members are aware of their roles if there is an incident or if an evacuation is necessary; staff and their backups are sufficiently trained to carry out these roles
- the required number of staff are trained in emergency and standard-level first aid
- all staff members are trained and prepared so that they know how to declare an emergency and initiate the alarm, and how to determine the required level of response (e.g., standby, escalation, evacuation or take cover).

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EMERGENCY RESPONSE PROCEDURES

The procedures described in the next sections provide a starting point for planning.

Responding to Fire

A response procedure for a school fire would address the following elements:

- when to sound the local fire alarm
- when and how to evacuate the school (for example, would an appointed person take the building's Emergency Services Kit with them to the Command Centre?)
- who is responsible for notifying the fire department and school superintendent
- under what circumstances staff members may attempt to extinguish the fire, and procedures for doing so
- when and how to permit people to re-enter the building, or to carry out further evacuation procedures if staff and/or students will be unable to return
- procedures for securing utilities
- responsibilities and procedures for filing written reports with the supervisor of schools and the Fire Marshal.

Steps for Responding to Toxic Substance Leak or Spill

For leaks or spills of less dangerous substances, see Chapter 7 for clean-up procedures. For leaks or spills of unmanageable amounts of a toxic substance, particularly those that pose an immediate danger, the emergency plan should include:

- when and how to evacuate
- who is responsible for requesting emergency services and informing appropriate school officials
- procedures and responsibilities for providing the appropriate MSDS to the emergency responder, hospital or physician
- procedures and responsibilities for reporting the leak or spill and completing any follow-up investigation.

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Steps for Responding to a Natural Gas or Propane Leak

Natural gas and propane are flammable gases that are used as fuels in science laboratories. Both are delivered under pressure. Any leakage of gas from pipes or fittings creates a risk of fire and/or explosion, particularly if the leakage is in a confined area, and especially if it remains undetected for some time. A slow continuous leak can lead to migration of gas through a room or building until it reaches a source of ignition, resulting in an explosive flash back to the source. A fire near the source of a leak may also cause the gas container or pipe to explode.

Emergency planning should address the following elements for natural gas or propane leaks that cannot be immediately stopped:

- when and how to evacuate the area
- who will alert the fire department and local officials
- under what circumstances staff members may attempt to localize and/or dissipate the leaking gas, and procedures for doing so.

Responding to Accidents and Medical Emergencies

To handle medical emergencies and serious injuries, each school is required by Occupational Health and Safety to have staff with emergency or standard-level first-aid training. These individuals would have the expertise to administer the Heimlich maneuver, mouth-to-mouth breathing and cardiopulmonary resuscitation (CPR).

This section outlines general steps for dealing with both minor and major injuries, including first steps to alleviate damage and to engage local emergency services. School districts may have additional procedures or regulations for responding to medical emergencies.

Chemical on the skin

Wash the area immediately with cool water, or soap and water, and continue for 15 to 20 minutes. Remove contaminated clothing. If significant harm is detected or suspected, seek medical assistance.

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Splashes into the eyes

Immediately flood the eye(s) with a gentle stream of cool water for 15 to 20 minutes, holding the eye(s) open if necessary. Proceed to get medical help to assess the condition of the eye(s) and ensure no further damage occurs. Alkalis produce more serious burns than acids, but flushing should be done immediately regardless of the substance.

Glass in the eye

Gently hold a gauze pad on the eye to prevent the eyelid from opening, and take the person to hospital for medical treatment.

Cuts

Put on disposable gloves to minimize risk of infection from the blood. Wash minor cuts with cool water to remove any foreign material, dry the area and cover with a bandage. In the case of major cuts with severe blood loss, apply a large compress, apply direct pressure with the heel of your hand and transport to the hospital. A tourniquet may be used instead, particularly if pieces of glass are suspected of being imbedded in the wound. For major cuts with minor bleeding, wash with cool water and cover with a gauze pad, then transport the victim to hospital for further medical help. If glass or any other sharp object may still be in the wound, do not attempt to remove it. Be careful not to put undue pressure on the gauze while transporting the victim, since circulation may be cut off completely.

Ingestion of chemicals

Check the MSDS for suggested treatment. The standard procedure is to have the victim drink plenty of milk or water and immediately transport him or her to hospital for medical treatment.

Burns

Place an ice pack or a gauze soaked in cold water on the burned area. Change the gauze frequently as it becomes warm. If the burn is severe, transport the person to hospital for medical assistance. If in doubt, seek medical assessment and/or treatment.

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Burning clothing

There is no directive that prescribes a particular method to extinguish burning clothing, but it is critical that whatever technique is used minimizes exposure time of the victim's skin to heat and does not subject others to burns. The "Stop, Drop and Roll" method is commonly recommended by fire departments. Some Fire Marshals advise the use of fire blankets to choke off air; however, fire blankets are not a *Alberta Fire Code* requirement and are not recommended by all fire departments. If a blanket is used, it must be removed from the victim as soon as the fire is out so that heat and sparks are not trapped against the victim's skin. Other options for putting out burning clothes are using a fire extinguisher, spraying the victim with water or using an emergency shower if available. Once the fire is out, follow the procedures for responding to burns described above.

Shock and fainting

Lie the person down if he or she is in shock. Loosen tight clothing, cover the person with a blanket and talk to him or her reassuringly. If the person has fainted, check to ensure the airway is clear. Make the head comfortable, cover the person with a blanket and leave him or her laying down. Ensure the airway remains open at all times. If there is a chance of injury due to the collapse, do not move the person until you can communicate with him or her to confirm no injury has occurred. If other injuries are present or any symptoms persist, seek emergency medical assessment and/or treatment.

Inhalation of toxic fumes

Move victim into fresh air and summon trained personnel who can administer oxygen and other medical procedures, if necessary. In severe cases, seek further medical treatment. If in doubt, seek medical assessment and/or treatment.

Other medical emergencies

Being prepared to deal effectively with emergencies involving serious existing medical conditions such as asthma, anaphylactic shock, diabetes or epilepsy requires open communication between school administration, counsellors and parents. Teachers need to know if students have these conditions, as well as what to look for and what to do if the student becomes symptomatic. Basic training could be provided to assist teachers in dealing with, for example, seizures or insulin shock. If in doubt, seek medical assessment and/or treatment.

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Accident Reporting

An *accident* is an undesired event that causes or may cause harm to individuals, property or the environment. When an accident occurs, the first concern is the injured. Priority can then be placed on systematic investigation and proper reporting of the accident.

By law, certain work-related accidents must be reported as soon as possible to Alberta Workplace Health and Safety. The *Alberta Occupational Health and Safety Act* requires employers to:

- report certain injuries or accidents, including any injury or accident that results in a fatality or in a worker being admitted to hospital for more than two days
- report any unplanned or uncontrolled explosion, fire or flood that causes (or could cause) a serious injury
- conduct an investigation whenever a serious injury or accident occurs, and prepare a report that is available for inspection.

Accidents involving workers that fall under the jurisdiction of the *Workers' Compensation Act* must also submit a report to the Workers' Compensation Board within 72 hours of the incident. Laboratory aides and technicians fall under the scope of the act; whereas teachers do not, except when teaching Career and Technology Studies (CTS) courses. Principals and assistant principals fall under the act if teaching CTS courses or if injured while involved in non-teaching activities. Students do not fall under the act unless on approved off-campus education programs such as work experience. The *Workers' Compensation Act* requires both the employer and the employee to report injuries that result in the loss of at least one full day's work, and all injuries that require medical aid.

Both Occupational Health and Safety and the Workers' Compensation Board may choose to investigate the accident.

Schools can improve safety and show compliance with accident reporting requirements by ensuring that:

- all accidents and injuries are recorded, reported and investigated as appropriate
- staff know when and how to report accidents, including where to access reporting forms and instructions
- staff know what kinds of accidents will be investigated
- staff receive appropriate orientation and training and understand their responsibilities
- all needed information is gathered and provided by supervisors for staff compensation claims
- general pre-planning has been done regarding accident investigation and reporting

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- the underlying causes of accidents are determined
- measures are taken to prevent accidents from re-occurring.

See Appendix E for a sample Accident/Incident Report Form. This sample shows the type of information that is required in an accident report, as well as who is required to complete the report.

Near-miss Reporting

A near-miss is an event that could, but does not, result in an accident. Near-misses are also referred to as incidents or potential accidents. Like accidents, near-misses are caused by unsafe acts or conditions. Examples of unsafe acts include handling of materials by someone without proper training, and failure to use personal protective equipment such as safety glasses. Examples of unsafe conditions include poor lighting, excessive noise and poor housekeeping.

Near-miss situations are often documented internally and information on the incident is shared among staff. In this way, near-miss reporting is a proactive means of improving safety awareness, tracking potential hazards and ultimately preventing accidents. Whenever a near-miss is recorded, it is important to identify, as far as possible, the unsafe acts and conditions that contributed to the incident. Actions can then be taken to reduce the risk of a similar incident or accident occurring in the future.

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Chapter 3
Facility Design and Safety Equipment

OVERVIEW

As the previous chapters have shown, many laws and regulations govern safety in science classes. Some of these relate to how we do things: the plans we put in place and the procedures we use. Others relate to the physical environment: the design of the facility and the safety supplies kept in that facility. This chapter outlines guidelines and rules surrounding facility design and safety equipment.

ASSESSING the SUITABILITY of Facilities for Science Activities

The selection and planning of science activities needs to take into account the strengths and limitations of available facilities. Although some introductory activities do not impose any facility requirements, many others—particularly at the secondary level—require some minimal facility characteristics (e.g., flat-topped surfaces are needed for activities with containers of liquids). For some activities, the use of purpose-built laboratory facilities is a practical necessity.

When deciding whether a given facility is adequate to the needs, consider the following factors:

- Does the facility have flat-topped surfaces? How much flat-top surface will the class need?
- Does the facility have sinks? How many will the class need? Is the number sufficient for clean-up and emergency flushing?
- How many students are in the class, and how much space does the activity require? Keep in mind that overcrowding increases risks and that the building code for science laboratories specifies that 4.6 square metres of space be provided for each student.

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- How is the facility configured? Does it allow the teacher to see all the students? Does it provide easy passage from one area to another without risk of bumping into one another?
- Does the facility have appropriate emergency response equipment (e.g., an eyewash fountain, a shower, fire extinguisher)?
- Does the facility have sufficient storage and/or adjacent preparation areas that minimize the need to transport equipment and supplies through the school? Is there a locked area for storage and preparation of chemicals? Is the room itself lockable?
- Does the facility have adequate ventilation?
- Does the facility have a functioning fume hood that can be used in teacher demonstrations?

In planning for science activities, teachers should also be aware of any local standards that may have been established. For example, in some cases a school or district may determine the maximum number of students for a given facility and/or the number of students under the guidance of one teacher in that facility.

FACILITY CHECKLIST

The following checklist is adapted from *Science and Safety, Making the Connection* (Council of State Science Supervisors, 2002). This is not an exhaustive checklist and is only intended to address the needs of science laboratories for Grades 7–12.

Layout and Space:

- ❑ The room has adequate space (4.6 square metres per student).
- ❑ Aisle width is adequate to accommodate equipment and students with physical disabilities (1.2–1.5 metres).
- ❑ Workspace per student is adequate (1.5–2.0 metres width of workspace per student, depending on the activity).
- ❑ The teacher can see students in all locations of the room.
- ❑ The general light level is sufficient (538.2–1076.4 lumens per square metre, with diffuse lighting preferred).

Safety Equipment:

- ❑ A telephone or intercom is available in case of emergencies.
- ❑ Fire detectors and heat detectors are installed in laboratories, science prep rooms, chemical storage areas, waste disposal areas, and any other high-risk areas.

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Exits:

- The room has two exits, both with doors that open outward and have reinforced glass viewing windows or peepholes.
- Doors open easily and do not require a key to exit.
- Doorway widths are sufficient to accommodate students with physical disabilities, allow movement of equipment carts and serve as emergency exits.

Construction Materials:

- Ceilings are constructed out of material with a low flame spread rating (e.g., drywall).
- Floors are even, free of cracks and have a non-skid surface (sheet flooring is preferable to tiles or carpets; tile floors should be covered with a non-skid wax).
- Lab surfaces are made of material resistant to acids, alkalis, solvents and temperate heat.

Ventilation:

- Air in the room is recycled and mixed with outside air at a rate of 4–12 complete laboratory air changes per hour, depending on the chemicals used, or a minimum of 15 L per second per occupant.
- The exhaust ventilation system is separate from that of the chemical fume hood.
- The exhaust hood(s) is/are located away from doorways, windows, high traffic areas or areas with disrupted airflow.
- There is at least one chemical fume hood that meets American National Standards Institution specifications, including an average face velocity of at least 0.5 m/s and individual face velocity readings above 0.43m/s. Exhaust is vented to the outside wall or roof vent.
- Fume hood controls are located outside the fume hood in an immediately accessible area (water taps may be located inside the cabinet if there is a main shut-off valve in another area of the lab).

Electrical:

- There are sufficient electrical outlets (i.e., located at intervals of 2–2.5 metres) to make extension cords unnecessary, and all power outlets meet *Alberta Building Code* standards.
- Outlets within 1.5 metres of water are equipped with Ground-Fault Interrupters.

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Plumbing:

- Plumbing is free of leaks or cracks, and drains are made of chemical resistant material.
- Worktops are lipped towards the sink.
- An eyewash station is available for all activities where there is risk of materials entering the eye.
- A plumbed-in eyewash station and shower are provided in senior high laboratories where chemistry is taught. (The preferred location of the shower is in an adjacent nook that is equipped with a wastewater holding receptacle, rather than direct drainage into a sewage system.)
- Portable eyewash stations, where provided, are filled with the appropriate solution.
- All eyewash stations—whether fixed or portable—are routinely maintained to ensure their function and cleanliness.

Storage and Preparation Facilities:

- Chemical storage area is adequate in size, well ventilated, isolated from students and has an adequate drain at the lowest point. See Chapter 9 for more specific guidelines.
- A preparation area is available for making solutions and storing inventories, MSDSs, WHMIS and TDG information.
- Adequate refrigeration is available for storing fresh tissue/organs, enzymes, specific chemicals, agar plates and perishables.

Other Resources (if possible and appropriate):

- Computer to track school equipment and chemical inventories and to access Internet information, e.g., regulations, MSDSs.
- Microwave to prepare materials such as gelatin and agar.
- Dishwasher to clean equipment, reducing the risk of injuries from broken glass and chemical exposure.

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SAFETY EQUIPMENT and SUPPLIES

Having the proper safety equipment and supplies in place in science areas of a school is critical to managing risks and dealing with emergencies that may arise. This section discusses essential safety equipment and some basic procedures for using these resources.

General Safety Equipment for Science Classrooms

With the exception of fire blankets, this list identifies general safety equipment that is essential in every classroom used as a science laboratory. Safety can be further enhanced by making sure teachers, students and technicians are familiar with the location and use of this equipment; that the equipment is easily accessible; and that safety posters are displayed.

Equipment	Comments
ABC-type dry chemical fire extinguisher	After use, the extinguisher will require service. Demonstrations should not be done with this extinguisher; a spare extinguisher may be reserved for that purpose. Refer to the Fire Extinguishers section in this chapter.
First aid kit	Refer to the First-aid Kits section in this chapter.
Eyewash station	Eyewash stations should meet Canadian Standards of Safety (CSA) and American National Standards Institution (ANSI) specifications. A plumbed-in type is preferred, as long as water is free of grit and contaminants. The water supply should be tempered by mixing hot and cold water and once activated should run hands free.
Simple/hand washing facilities	Hand washing facilities should be in or near each science classroom.
Emergency shower (if chemicals are used)	If large amounts of caustic or flammable stock are used, a deluge shower is required as specified on the chemical's MSDS. If diluted caustics or small amounts of flammable stock are used, a hand-held, telephone-style shower is sufficient.

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Fume hood (if chemicals are used)	Fume hoods should meet ANSI specifications and should be inspected at least once a year by a qualified person. Fume hoods should be used when dispensing volatile liquids, performing reactions that generate toxic fumes or diluting substances such as acids and bases.
Ultraviolet goggle sterilizing cabinet	A sterilizing cabinet is recommended in junior and senior high schools (one cabinet can serve several classrooms). The cabinet should have interlocking doors. A cabinet is not needed if each student has his or her own goggles or if other methods of sterilization (e.g., disinfectant solution) are used.
Discretionary * Fire blankets (Not an *Alberta Fire Code* requirement)	Fire blankets are not recommended by all fire inspectors and require proper usage to avoid further damage to skin. Check with your local Fire Marshal for more details. Blankets containing asbestos should be removed from the school.

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Personal Protective Equipment

The following list identifies personal protective equipment that should be present in every classroom that is used as a science laboratory. If injuries to students result from the failure to have or use personal protective equipment, negligence may be claimed.

Equipment	Comments
Protective goggles or plastic face shields (one per student and teacher)	Eye protection should be CSA approved and should be worn whenever there is the risk of eye injury. Goggles should have fitted side-shields. If glasses are normally worn, goggles should fit over them. Protective equipment should be splash proof if used for chemistry. Some facility or procedure for sterilizing goggles after use is strongly recommended if goggles are shared.
Laboratory coats or aprons	Laboratory coats and aprons should be made of approved material only, and should be worn when working with chemicals and when appropriate in other science activities (e.g., biology). Coats are preferable to aprons.
Sleeve protectors	Sleeve protectors should be worn when required.
Non-latex disposable gloves	Gloves should be worn when handling hazardous chemicals and in biological experiments. Gloves should be used in combination with other measures because gloves may only slow down transmission of some materials, not completely prevent it. Note that some students and staff may have latex allergies.
Heat resistant gloves	Gloves should be made of treated texture silica or woven fabric. Do not use asbestos gloves.
One pair of beaker tongs	Use tongs with heat resistant gloves when handling very hot equipment.
UV filtering glasses	Eye protection should be worn when UV sources are in use (e.g., discharge tubes, mercury or ion arcs, lamps for fluorescent "black light" experiments). Appropriate glasses include Shields sunglasses or any glasses labelled "Blocks 99% or 100% of UV rays," "UV absorption up to 400 mm," "Special Purpose," "BS" or "Meets ANSI UV requirements."

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Fire Extinguishers

The following chart shows types of fire extinguishers that may be appropriate for use in schools (the type will be identified on an inspection label on the unit). ABC extinguishers are recommended for all school locations because they avoid the need to classify the fire and select the appropriate extinguisher, and because only one operational procedure must be learned and remembered.

Type	Extinguishing Agent	Use
Class A	Water	Fires involving ordinary combustible materials such as wood, cloths or paper.
Class B	Dry chemical foam, carbon dioxide	Fires involving flammable liquids such as solvents, greases, gasoline or oil, and fires involving ordinary combustible materials.
Class C	Dry chemical and carbon dioxide	Fires involving electrical equipment.
Class D	Special dry powder medium or dry sand.	Fires involving combustible metals, magnesium, sodium, lithium, powdered zinc.
Class ABC	Dry chemical	All materials and fire types.

Schools can maximize the value of fire extinguishers by:

- placing extinguishers near an escape route, not in a "dead end" location
- ensuring all teachers and support staff working in the science area know the location of all fire extinguishers, and understand when and how to use the kinds of fire extinguishers installed on site
- having fire extinguishers inspected once a year by the local fire department, with inspection records kept by the principal or district administrator.

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First-aid Kits

First-aid kits are required under the *Occupational Health and Safety Code*. A first-aid kit is also a requirement on all field trips (see page 402 of the *Occupational Health and Safety Code* at http://www3.gov.ab.ca/hre/whs/publications/pdf/ohsc-1.pdf.

Kits are available from St. John Ambulance, Canadian Red Cross and most science supply companies. Kits are designated by number. A number 1 kit is recommended for classrooms accommodating anywhere from 11 to 49 people. Facilities accommodating 50 to 99 people require a number 2 first-aid kit. The contents should be checked and replenished regularly. The kit container should be clearly marked and readily accessible, and should keep the contents dry and dust free.

The contents of a level 1 kit include:

10	antiseptic cleansing towelettes, individually packaged
25	sterile adhesive dressings, individually packaged
10	10 × 10 cm sterile gauze pads, individually packaged
2	10 cm × 10 cm sterile compress dressings, with ties, individually packaged
2	15 cm × 15 cm sterile compress dressings, with ties, individually packaged
2	7.5 cm conform gauze bandages
1	7.5 cm crepe tension bandage
3	cotton triangular bandages, minimum length of base 1.25 m
1	2.5 cm × 4.5 m adhesive tape
5	safety pins, assorted sizes
1	pair of scissors
1	pair of tweezers
1	artificial resuscitation barrier device with a one-way valve
4	pairs of disposable latex or surgical gloves
1	first-aid instruction manual (condensed)
1	inventory of kit
1	waterproof waste bag

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Equipment for Clean-up and Disposal of Chemical Spills

The following list identifies items to keep in the laboratory in a clearly identified and accessible location for clean-up and disposal of spills. See Chapter 7 for clean-up and disposal procedures for different kinds of chemical spills.

Items	Comments
Acid, base and solvent spill kits	Spill kits are used for absorbing spills or diluting solutions of chemicals. Use these kits for clean-up of small spills (follow manufacturer's instructions). Absorptive materials are also available in "*pillow*" form (e.g., at the time of writing "*Hazorb spill control pillows*" were available at Lab Safety Supply Inc. Other products and suppliers may soon be available).
Several litres asbestos-free vermiculite, bentonite or diatomaceous earth in container with scoop	These materials can be used for spills of solid chemicals, especially powders, and viscous or sticky liquids. Containers should be clearly labelled and contents disposed of safely.
Containers suitable for waste chemicals and solvents	Each chemical must be collected separately and labelled according to WHMIS specifications. Waste solvents should be collected only in a safety disposal can with automatic pressure release closure.
Waste container for glass and sharp objects	A separate container for these items reduces the chance of injury to maintenance and janitorial staff responsible for normal garbage disposal.
Large container of dry $NaHCO_3$ (baking soda)	Baking soda can be used to neutralize strong acids before disposal.
Plastic dustpan and brush	Use the dustpan and brush for sweeping up used sand, vermiculite or broken glass. Wash and dry both thoroughly after use.

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45-cm long chemically-resistant rubber gloves	Gloves should be worn whenever dealing with spills, especially when broken glass is involved. Gloves are usually included with spill kits.
Heavy-duty garbage bags	For disposal of all solid waste, including used sand, vermiculite and contaminated broken glass. Dispose of each spill separately. Tie bags very securely; double bag if necessary and label for disposal.
Biohazard bags or extra thick garbage bags	For disposal of biological specimens and cultures.
Respirator	For pickup of some spilled chemicals as noted on MSDS sheets. Schools offering Science programs at grades 9–12 should have at least one respirator per prep room or department.

MONITORING and ASSESSMENTS

The best way to evaluate and improve the condition of science facilities, as well as the adequacy of equipment and materials, is through regular monitoring and periodic formal assessments, for example at the end of the school year. Monitoring and assessment can be done in conjunction with tracking items on a computerized inventory. Checking science facilities and equipment lets you take a proactive approach to repairs and maintenance, which reduces risks.

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Chapter 4
Risk Management

OVERVIEW

In addition to the overall policies, planning and equipment that impact on science safety, we also must consider risks related to the kinds of activities we choose. The selection of an experiment or demonstration should take into account what that activity will achieve, what potential hazards it involves and how to control or minimize these hazards. Risk management also means ensuring that staff have the proper safety education and training, including WHMIS and TDG training, and teaching safe attitudes and behaviours to students.

RISKS

Inherent Risks

Inherent risks arise as the direct consequence of the particular materials and activities used. Most science activities involve some inherent risks. For example, an activity aimed at helping students learn about heat might require use of heat sources and pyrex containers, creating an underlying risk of burns and minor cuts. More serious risks are inherent in the use of particular chemicals, equipment or procedures.

Before selecting materials and activities, it is important to consider ways to minimize inherent risks. For example, in planning an activity that requires elementary students to transfer liquids from one container to another, teachers can avoid the inherent risk of cuts caused by broken glassware by opting instead to use plastic containers. Similarly, a teacher could minimize inherent risks in an activity involving handling of acid solutions by preparing the solutions in advance, rather than have students prepare them as part of the activity. Decisions such as these should also take into account the learning outcomes, the grade level, and the skill level of students.

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Situational Risks

Situational risks arise from the context in which the materials and procedures are used. For example, if heat sources are used in a crowded workspace, the situation of crowding creates an additional risk of burns. If situational risks are not considered, an activity that has low inherent risk can grow into a high risk situation.

Situational risks can be minimized by ensuring that:
- teacher and students are aware of inherent risks involved in an activity
- teacher and students understand and are able to carry out appropriate procedures
- steps are taken to minimize potential distractions or disruptions
- workspaces are adequately sized and well organized
- sufficient supervision and guidance are provided at all times.

The most effective way to minimize situational risks is through a collaborative effort between teachers and students. Teachers thus need to enlist students in planning for safety, and in establishing safe classroom procedures. This strategy for risk minimization can be supported by involving students in activities such as the following:
- identifying risks
- developing class lists of required and prohibited laboratory activities
- creating posters that show appropriate and inappropriate activities
- developing a safety contract for students to sign at the beginning of the school year.

CHOOSING SCIENCE ACTIVITIES

Safety is a primary concern in selecting activities for science classes. Factors to consider before proceeding with a science activity include:
- potential hazards (both inherent and situational risks)
- the knowledge, skills and maturity of the students
- the experience and expertise of the teacher
- the equipment and facilities available to safely carry out the activity.

Inherent risks increase dramatically with the use of materials that are highly toxic, corrosive or flammable. The selection of materials can thus help minimize risks. Even highly qualified teachers need to assess the risks of different alternatives and select the one that

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presents the least hazards for students—even though another choice might produce a more spectacular result. Alternatively, an activity might be carried out as a demonstration by a teacher with appropriate safety precautions in place. A further alternative to consider to avoid high-risk substances is to use videos or CD–ROMs to show their reactions. Although this takes away from the drama of a live demonstration, it effectively provides a visual form of what students need to know and understand.

In addition, many of the approaches described in Chapter 9 under the heading Strategies for Minimizing Hazardous Waste Production are excellent ways to reduce safety risks. These strategies include microscale experiments, dispensing pre-measured quantities of chemicals and using laboratory stations.

Teachers should also be aware that under the Occupational Health and Safety Act Regulation (Part 1, item 14), workers have a duty to refuse "work that may endanger the worker or others except under the direct supervision of a worker who is competent to perform the work." This provision under the act could provide the basis for a substitute or regular teacher to refuse to lead science activities that they do not have the knowledge, training or experience to perform safely.

Field Trips

Field trips are a valuable addition to any science program, giving students the opportunity to explore applications of science and to investigate living things in their environment. Potential hazards associated with offsite excursions depend on the nature of the trip and the site visited, but in general the possibility of accidents can be greatly reduced if the field trip is well planned and organized. Effective organization includes briefing students on safe and unsafe activities, providing adequate supervision, and ensuring that first aid is available.

Museum, Zoo or Industrial Site

The two primary concerns for these kinds of trips are safe transportation and adequate supervision. If parent-supplied transport is to be used rather than buses, review district policy for guidelines. The number of supervisors to accompany the students will vary with the age and number of students, the type of activities planned and the site itself. Be aware of any onsite hazards if these exist, and make students and supervisors aware of them prior to the trip. Also ensure that a first-aid kit and someone who can provide first aid is available

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on site at all times. In many cases this may be available at the site to be visited, but if in doubt this should be included in trip preparation.

Nature Site

Field trips to environmental sites present their own set of challenges because students are exposed to the weather, physical hazards and local organisms. Taking the following precautions can reduce risks.

- Be thoroughly familiar with the site and any potential hazards. Visit the site prior to the field trip if necessary.
- Provide students with a map of the site, identifying the specific locations to be visited, the routes by which they will get there and the potential hazards.
- Specify the clothing and footwear to be worn, and other special requirements such as insect repellant or sunglasses.
- Use appropriate precautions and equipment if working on or near water (e.g., whistles, life jackets, throw line, buddy system).
- Ensure supervisors are located so that all students have an adult relatively nearby at all times.
- Have a first-aid kit and someone who can provide first aid on site at all times.
- Maintain access to a vehicle at all times in case of an emergency.
- Carry a cell phone to access emergency services and information.

For more information on biology field trips, see Chapter 5.

SAFETY AWARENESS and EDUCATION

As discussed in Chapter 1, responsibility for science safety is shared by many individuals at many levels. As a result, proper staff training, particularly for individuals at the school level, is an essential part of school safety planning. Students also need to know and understand the safety policies and procedures in the classroom and school, as well as consequences for disobeying these policies. With the proper education, all staff and students will be able to act responsibly, follow safety procedures to avoid hazards and injury, and deal appropriately with injury or accidents if they occur.

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Staff Training

Training of school staff, particularly science teachers, would generally cover the following:

- legislation that regulates or defines safety standards in the school, particularly Occupational Health and Safety, Environmental Protection, WHMIS and TDG regulations
- due diligence and staff responsibilities
- management of chemicals, including how to select, use, store and dispose of chemicals; how to respond to spills and other accidents; and how to read and use MSDSs
- school and/or district safety policies for science classrooms, laboratories and field trips
- response to accidents, including first-aid procedures
- accident and near-miss reporting procedures.

WHMIS

As described in Chapter 1, the Workplace Hazardous Materials Information System is designed to identify and minimize risks for human health and safety. Under federal and provincial legislation, people in every workplace have the right and responsibility to know whether materials they are working with are hazardous, the nature of the hazard and what safety measures to take. Although students are not specifically referred to in WHMIS, except in the case of registered apprenticeship or work experience programs, their presence in the school workplace suggests that a level of care be provided consistent with WHMIS standards. This implies making students aware of any potentially hazardous materials in areas accessible to them, and providing training in the safety skills needed to use these materials. The safest and most practical approach is to manage the environment so that student access to these materials is limited to times of teacher supervision.

Although the legal force of WHMIS requirements is not well defined with respect to students, this is not the case when it comes to school staff and school districts. School staff are bound by the WHMIS requirements in their capacity as workers, and each school district is bound by the regulations that apply to employers. This means, among other things, that science teachers and other school staff who work with potentially hazardous materials, must be WHMIS trained. This training must be provided by the employer to enable the employee to:

- recognize risks of substances they are handling
- learn how to safely handle these materials
- know where Material Safety Data Sheets (MSDSs) are filed and how to use the information on them.

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This training must be product- and site-specific, so that staff know what hazardous materials they will encounter in their work location and where the hazardous materials and safety equipment are located. Schools may find it useful to maintain records of courses taken, but this is not a formal requirement. The ability of workers to demonstrate the above knowledge and skills is sufficient evidence of the requirement being met.

For more details on what must be covered by WHMIS training, refer to part 1 of the *Occupational Health and Safety Code*, available at www.worksafely.org.

To find WHMIS training agencies in your area, refer to Appendix H or contact Workplace Health and Safety. At the time of publication, the contact number was 1–866–415–8690. A number of online and CD–ROM training programs are also available from Workplace Health and Safety.

Transportation of Dangerous Goods Act and Regulations

The purpose of the TDG regulations is to protect the general public and the environment during the transportation of dangerous goods. TDG requires that anyone transporting, shipping or receiving dangerous goods be trained and have their training certificate available for inspection. A training certificate is valid only for three years; after that time, the individual must be re-trained and issued a new certificate. These requirements apply to anyone who:

- offers dangerous goods for transport, such as a shipper at a chemical supply company
- receives dangerous goods, such as the individual at a school who accepts delivery and signs the delivery docket or manifest
- handles dangerous goods by loading or unloading materials
- drives a vehicle carrying dangerous goods.

Principals and administrators are responsible for ensuring that staff members who receive or ship dangerous goods are TDG trained and certified. Certified staff will know:

- the classes of dangerous goods and associated hazards
- the information that is required on shipping documents
- what labels and markings are required on packages and containers
- what placards must be shown on vehicles
- what protective measures to adopt during transport

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- what responsibilities they have if they are the shipper, receiver or transporter of the dangerous goods
- how and when to report accidents or incidents involving dangerous goods, especially those releases deemed dangerous occurrences.

Alberta Environmental Protection and Enhancement Act

The *Alberta Environmental Protection and Enhancement Act* (AEPEA) and its regulation outline a system to protect, improve and ensure wise use of the environment. One way that principals and administrators can ensure compliance with AEPEA regulation is by providing staff education and training. With proper training, staff who handle chemicals will know:

- their responsibilities regarding reporting, clean-up and disposal
- what emergency and reporting procedures to follow if there is an accidental leak or spill
- how to confine the release and ensure prompt clean-up takes place to restore the environment to a satisfactory condition
- what preventive and protective measures to use
- how to ensure that chemicals are used, handled and disposed of in an environmentally safe manner
- how to implement measures to minimize and/or recycle hazardous waste.

Use of Safety Equipment

Science teachers need to be familiar with the location, use and limitations of all safety equipment in the science area. Such familiarity may require initial training and periodic refresher sessions. Sharing this information with students will help them take appropriate action if the teacher is not immediately available in an emergency or accident.

Student Training

Part of the role of science educators is not only to ensure a safe learning environment, but also to instill in students an understanding of their own responsibilities in the science classroom. Learning about science includes learning to respect the materials being used, and this respect can be taught only by example. In this way, science teachers are role models—advocates and practitioners of safety. Increasing students' awareness of safety issues in general and knowledge of safety practices specifically is one of the most important ways to reduce situational risks.

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Establishing School-wide Safety Training

Safety training is an integral part of learning laboratory techniques. Though infrequently put to the test, safety training is an excellent way of encouraging students to make safety a lifelong practice at home and in the workplace. Safety expectations can be taught in a number of ways:

- handing out written copies of good laboratory practices and reviewing these with students throughout the term
- posting lists of safe practices in appropriate areas and reminding students of them on a regular basis
- reviewing specific safety issues and procedures before each activity, including relevant WHMIS information if applicable
- modelling safe behaviours during all activities.

For practical reasons, identifying routines, responsibilities and behavioural expectations for students in the science classroom and laboratory may best be done at a department level. This allows for a general safety policy to be established for all science classes, which can be monitored by a science department head or an appointed teacher. This also ensures consistency across science disciplines and courses, which eliminates confusion as to student responsibilities and what they can or cannot do. Making safety an integral part of every course helps to reinforce its importance and conditions students to think about safety whenever they undertake any activity in the laboratory.

Developing Safety Awareness and Responsible Habits

One of the most important ways to promote safety in science classrooms is to increase students' awareness of safe practices and help them develop responsible attitudes. Good laboratory practices can be broken down into three time periods.

Before entering the laboratory:

- confine long hair and loose clothing
- put on closed-toe shoes
- put on eye protection
- cover exposed areas of the body with chemical-resistant clothing (protective gloves, aprons or lab coats, and face shields) when using toxic or corrosive material
- know the hazards of chemicals to be used
- understand response procedures in case of an accident; if unsure, ask the teacher or check the MSDS information.

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While in the lab:

- respect the safety of others at all times
- never work alone or unsupervised
- do not eat, drink or keep food in the lab
- never pipette by mouth
- replace stoppers and caps of chemical containers immediately after use
- treat a substance as hazardous unless definitely known as safe—read the WHMIS label to be sure
- work in a fume hood if using substances that produce a hazardous vapour or dust.

Prior to leaving the lab:

- dispose of hazardous wastes in specified containers or as instructed by the teacher
- turn off and put away all equipment, and clean all glassware
- wash hands thoroughly.

The more awareness students have of these issues, the greater chance they will develop safe and responsible habits of mind. See Appendix A: Science Safety Rules and Procedures for a more comprehensive list of "dos" and "don'ts".

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Part B – Specific Hazards

Chapter 5
Biological Hazards

OVERVIEW

While chemical hazards may be the most obvious safety concern in the science classroom, biology-related activities present their own risks. Potential biological hazards include pathogens in specimens or cultures, and allergens in plants, animals or the chemicals used to store specimens. This section discusses common biological hazards, suggests ways of reducing associated risks and identifies official restrictions on biological materials in Alberta schools.

CHEMICALS in BIOLOGY ACTIVITIES

Many activities in biology classes require the use of chemicals. As with any use of chemicals, accident prevention depends on assessing and minimizing risks related to the specific chemicals used. General steps for managing risks include:

- choosing the safest chemicals possible
- being aware of potential dangers
- instructing students in proper handling procedures and insisting that they are followed
- using appropriate protective equipment.

See Chapters 7, 8, and 9 for more information on selecting, storing and using chemicals. The most frequent known causes of laboratory-acquired infection are oral aspiration through pipettes, animal bites or scratches, and contact with an animal. Other common causes include cuts or scratches from contaminated glassware, cuts from dissecting instruments, spilling or dropping cultures, and airborne contaminants entering the body through the respiratory tract.

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ACCIDENTAL INFECTIONS: specimens and cultures

Use of Human Tissue and Fluid Specimens

In September 1987, following a review of the potential means of transmitting hepatitis or AIDS (acquired immune deficiency syndrome), Alberta Learning issued a directive prohibiting activities deemed to cause unwarranted risks. All activities involving the extraction and analysis of samples of human fluid or tissue are prohibited in Alberta schools. This directive is noted in Alberta Learning's *Guide to Education: ECS to Grade 12* and is further described in the document *A Clarification of Statements Prohibiting the Use of Human Body Substances in the Alberta Science Curriculum,* 1988.

This prohibition applies to all activities involving extraction of human tissue and fluid samples, including cheek cells, blood, saliva and urine. Alternative materials that schools may want to consider in place of these samples include prepared slides and simulated urine and blood. These materials are available from scientific and educational suppliers. In some instances, other mammalian, amphibian or reptilian sources may be substituted. There are also excellent videos, computer software and Web site resources available on these topics.

Cultures

Most micro-organisms are not harmful to humans and can be safely cultured. However, culturing harmless micro-organisms still has the potential risk of unintended contamination by pathogenic forms that may be simultaneously introduced to the culture plate. Although the body can routinely destroy small numbers of these pathogenic forms, it may be overwhelmed by large numbers. Teachers can reduce this risk by being aware of the hazards presented by infectious agents and their possible sources, and by using proper handling, storage and disposal techniques when working with cultures.

Some general practices to consider when culturing micro-organisms include the following.

- Do not intentionally culture anaerobic bacteria or pathogenic organisms. Pathogenic organisms can be bacteria, viruses, fungi or protozoa. Examples of these include:

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  - bacteria causing tuberculosis and pneumonia
  - viruses causing measles and small pox
  - fungi causing athlete's foot and ringworm
  - protozoa causing giardiasis and amoebic dysentery.
- Only encourage growth of micro-organisms that occur naturally on moldy bread, cheese or mildewed objects. Using swabs from telephones, door knobs, lavatories or similar sources increases the likelihood of unintentionally culturing pathogenic forms of bacteria. If these sources are used, culture the plates for a minimum time period and dispose of them as soon as possible.
- Grow cultures only at room temperature or in the range of 25°C to 32°C—incubation at 37°C encourages growth of micro-organisms capable of living in the human body.
- Use a culture medium that is properly sterilized by autoclaving to avoid contamination from other sources and to minimize the chance of culturing pathogenic forms of bacteria.
- Use disposable Petri dishes rather than glass ones. When no longer needed, the cultures and plates can be disposed of in the regular garbage in a double-strength plastic bag.
- After inoculating the medium with micro-organisms, replace the cover and tape the plates shut. Subsequent observations can be made through the cover.
- Clean up any spills using proper procedures:
  1. Put on disposable gloves.
  2. Place paper towels over spill.
  3. Pour disinfectant such as 10% bleach solution on top of the towels and leave for 10 to 15 minutes.
  4. Wipe up the spill with the towels and discard into an airtight plastic bag or other appropriate container.
  5. Autoclave if possible.

Owl Pellets

Commercially purchased owl pellets are sterilized and do not pose any infectious hazards. This will not be the case with specimens that are personally collected in the wild by the teacher or any other individual.

Dissection

Animals and/or organs for dissection come in either preserved or fresh form. Two potential hazards that exist with dissections are infections and accidental cuts from sharp scalpels.

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Preserved Specimens

Specimens sold for dissection now commonly come in an alcohol-based solution, thus avoiding the need to use formaldehyde or formalin. (See the Chemical Hazard Information Table in Chapter 8 for hazards associated with formalin and formaldehyde.) If specimens are injected with formalin, or preserved in a formalin solution, a chemical called "infutrace" can be used to convert the formaldehyde into a non-toxic product, eliminating exposure to the formaldehyde and its fumes.

Specimens should be removed from the shipping solution using gloves and tongs, and rinsed thoroughly before proceeding. If smaller numbers of specimens are required, vacuum-packed specimens may be a good alternative.

Fresh Tissues

Fresh beef, pork and lamb organs and tissues are most commonly used for dissection (chicken often carries Salmonella, and is not a good option for dissection work). Organs and tissues obtained from slaughterhouses or store meat departments will have been inspected for infectious agents. If kept refrigerated, they should be stable for 10 to 14 days. Handle as you would fresh meat.

High-risk materials, such as animal tissues that potentially carry infectious agents, are controlled by the Health of Animal Regulations. For example, these regulations have recently placed restrictions on the availability of tissues and organs from the heads of Alberta cattle because of bovine spongiform encephalopathy (BSE). Currently, all head tissues and organs from cattle over 30 months of age are to be removed and condemned; cattle under 30 months old are considered noninfectious. Check with a local slaughterhouse to determine what materials are available for dissection at any time.

General safety precautions when dissecting include the following.

- Use preserved specimens or inspected animals or animal parts.
- Use dissecting gloves.
- Discard specimens in double bags and place in biohazard bins immediately after dissection.
- Empty bins the same day dissection materials are discarded as some bacteria can grow even on preserved specimens.
- Clean equipment, wipe lab benches and wash hands after a dissection.

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Activities Requiring Mouth Use

Some activities that involve the mouth include swabs in taste testing, phenylthiocarbamide (PTC) paper, spirometer mouthpieces and plastic-wrapped thermometers. To minimize risks during these activities, consider the following guidelines:

- avoid mouth pipetting (even if pipetting bulbs are not available), as it can result in accidental ingestion of fluid
- ensure that any components that are placed in the mouth are used only once, then sterilized or discarded
- check that students do not have bleeding gums or open wounds in the mouth, which increases risks greatly
- ensure that students wash their hands thoroughly before and after each activity
- after use, disinfect items, place in a secured, double-strength plastic bag and dispose of in regular garbage.

Syringes

The most serious hazards associated with syringe use are accidental inoculation and aerosol production. The best way to eliminate these hazards is to avoid the use of needled syringes in science classes.

Inoculating Loops

Inoculating loops pose one major hazard. The film held by a loop may break, producing an aerosol causing atmospheric contamination and subsequent inhalation. To minimize this risk:

- avoid jerky motions, shaking the loop or agitating the liquids
- dip inoculating loops into ethanol before flaming (bearing in mind the flammability of ethanol)
- allow the hot loop to cool after flame sterilization to avoid spattering when the loop is subsequently inserted into a micro-organism sample.

Centrifuging

Centrifuges require close monitoring to ensure the careful balancing of inserted tubes and their contents. The centrifuge lid should remain in place during the time of operation. After use, centrifuges can be cleaned with ethanol under a fume hood to kill any bacteria present.

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PLANTS and ANIMALS

Some basic safety considerations go along with the use of live plants and animals in science classrooms. To minimize the risk of infection and injury from live animals, consider the following common-sense precautions:

- Be very selective in the organisms brought into the school. Check for student allergies and diseases the animal may carry.
- Consider how you will dispose of the animal before acquiring it.
- Use domesticated animals or those available through reputable, licensed pet stores.
- Know and use proper handling techniques.
- Wear gloves to protect against biting and scratching.
- Explain to students the importance of acting respectfully and responsibly around the animals. Ensure that students do not tease the animals or put their fingers or other objects into the cages.
- Maintain animals in a clean, healthy environment.
- Discourage students from bringing sick animals into the laboratory, and do not allow students to bring in any animals that have died from unknown causes.

When selecting plants, be aware that many plants are poisonous, including a number that are often used as house plants. Make a point of checking for toxic properties of plants before using them in the classroom, and ensure that students wash their hands after handling plants or plant parts.

Common poisonous plants to be aware of include:

- Plants poisonous to touch due to exuded oils:
  Poison ivy (*T. radicans*; *R. diversiloba*)
  Oleander (*N. oleander*)
- Toxic house or garden plants:
  Poinsettia (*E. pulcherrima*)
  Dieffenbachia (*D. maculata*)
  Castor bean (*R. communis*)
  Mistletoe (*V. album*)
  Lantana (*L. camara*, etc.)
  Hyacinth (*Hyacinthus orientalis*, *Scilla nonscriptus*, and *Agraphis mutans*)
- Other plants that are poisonous when eaten:
  Tansy (genus *Tanacetum*)
  Foxglove (*D. purpurea*)
  Rhubarb leaves (*R. rhabarbarum*)
  Baneberry (*Actaea pachypoda; Actaea rubra*)
  Marsh marigold (*Caltha palustris*)

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CLEANLINESS in BIOLOGY LABORATORIES

Areas where organisms are kept or cultured must be given special attention with regards to cleanliness. General safety guidelines to consider include the following:

- Do not store or consume food in these areas.
- Wash all used surfaces with a disinfectant after each activity. Contact Health Canada, your local Health Authority or a science supply catalogue for appropriate disinfectants.
- Clean shelves, cupboards, animal cages, autoclaves, fridges and other items at weekly intervals using an appropriate disinfectant.
- Wash hands after handling any kind of organism(s).
- If an autoclave is not available, sterilize equipment used in microbiology by boiling in a pressure cooker for 10 to 15 minutes, or heating in a kitchen oven if a pressure cooker is unavailable (the heat provided by a microwave is not uniform enough for this purpose). An ultraviolet light cabinet can be used to sterilize external surfaces. Liquid disinfectants and germicidal agents generally will not provide complete sterilization.

FIELD TRIPS

Besides the usual safety considerations that must be addressed during travel and at the trip site, some additional concerns should be given attention for field trips involving biological activities. These include the following:

- Allergic reactions, toxic effects or accidental infections. Be aware of any student allergies to plants, animals, pesticides, herbicides or other materials. Also be aware of dangerous plants or animals that may exist in the area such as stinging nettles, poison ivy or rattlesnakes, and bring appropriate first-aid materials.
- Disease-carrying parasites such as ticks carrying Lyme disease. Students should check their clothing and other belongings for these organisms before returning to school.
- Diseases associated with handling animals. For example, deer mice can carry hantavirus and bats often carry rabies.
- *Proper storage, MSDSs and labelling* of fertilizers, special foods or other chemicals purchased for live specimens collected.

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Chapter 6
Physical Hazards

OVERVIEW

Physical hazards include mechanical, electrical, heat, sound and radiation hazards, many of which can occur in all kinds of science activities, not just in physics laboratory activities. Hazards in each of these categories have the inherent potential to cause injuries (or, in some extreme cases, even death), but by taking general precautions, such as using appropriate protective equipment and emphasizing routine safety, physical hazards can be easily minimized.

MECHANICAL HAZARDS

Mechanical hazards rarely exist in a well-maintained laboratory where equipment is commercially produced, approved and in good working order. In general, safety can be increased by ensuring that equipment is well maintained, that all equipment is turned off before leaving the area for any reason, and that students use equipment only with teacher supervision. In addition, there are some risks and safety measures to keep in mind when using specific kinds of equipment.

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Rotating Machinery

Machinery with rotating parts can catch loose clothing, hands or hair, potentially causing serious injuries. Uncovered parts may also fly off, creating additional risk, especially for eye injuries. To minimize risks:

- ensure rotating shafts, belts and pulleys are covered by guards, lids or covers
- check devices attached to a rotor before use to ensure that they are tightly fastened
- wear (and have students wear) eye protection when using uncovered, rapidly rotating parts, as in the demonstration of centripetal force and circular or periodic motion
- have students stand back as much as possible.

Tools

Careless use of tools or use of tools in poor condition can cause injuries to the hands, eyes, head and limbs. To minimize risks:

- regularly check tools for defects or damage
- provide students with clear instructions on safe use before they have access to tools.

Cutting Tools (scalpels, razor blades)

These instruments tend to be very sharp: careless use can quickly result in deep cuts on the fingers and hands. To minimize risks:

- use extreme caution in handling cutting tools, and ensure students do the same
- replacement of blades is best done by teachers or technicians
- wear eye protection when using cutting tools in case blade breaks.

Magnets

Large, powerful magnets or electromagnets can attract other magnets or iron/nickel objects with surprising force, which can cause painful pinching of fingers or hands if caught between the two. To minimize risks:

- inform students of this hazard before such magnets are used.

Glassware

Any kind of glassware has the potential to break, thus creating the risk for cuts or spilled materials. To minimize risks:

- use Pyrex glassware, which will not crack when heated
- avoid using glass containers that are cracked or chipped, since they may crack further during the experiment

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- clean up any broken glass immediately and dispose of in special waste bins.

ELECTRICAL HAZARDS

The two major risks related to electricity are electrical shock and fire. Some specific hazards and precautions are described below.

Faulty Wiring

Loose or broken connections or frayed connecting cords may create a a short circuit. This can result from contact of the lead-in wires or internal connections in the equipment. Fire, electrical shock or equipment damage may result. To minimize risks:

- check external wiring of equipment before use.
- verify normal function before making equipment available for student use.

Heavy-duty Usage of Lightweight Equipment

Equipment damage and overheating, and therefore fire, are always possible if equipment is in prolonged use at power ratings greater than the item was designed for. To minimize risks:

- use equipment only as intended.

Electrical Equipment Near Water

Use of electrical equipment near water creates the potential for electric shock if water gets into the electrical system. To minimize risks:

- ensure equipment used near sinks or other water sources is properly insulated and grounded
- if water gets into the electrical equipment, unplug immediately and do not use again until completely dry.

Electrical Equipment Near Flammable Liquids

The rotor of an electric motor generates sparks as it rotates past the brushes, which can ignite flammable vapours under poorly ventilated conditions. To minimize risks:

- ensure that electrical equipment is used only in properly ventilated areas, away from flammable liquids.

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Short Circuits

Short circuits quickly heat up the wiring, which may lead to skin burns if touched or cause a fire if wires are near flammable materials. Completing a circuit between terminals of a dry cell or dry cells, particularly those in series, without adding any resistance in the form of a bulb or other electrical device, will create similar hazards. Severe shorts may cause dry cells to melt giving off toxic fumes and possibly exploding. To minimize risks:

High Voltage Equipment

Some student-wired laboratory set-ups and teacher-made demonstration equipment have the potential to deliver a high voltage discharge. Common risks include the following.

- Capacitors that build up and store current can discharge on contact, generating a powerful shock in the process.
- Polarized capacitors can explode if incorrectly connected into a circuit.
- Tesla coils can cause severe skin burns.
- Electrostatic generators, particularly the Van de Graaf, can cause serious shocks if students join hands.
- Isolation transformers that use 120V AC current can be fatal since only one wire needs be touched.
- Air tables and other electrical equipment with faulty wiring can cause shocks.

To minimize risks:

- ensure high voltage equipment is handled with extreme care
- ensure any use of such equipment is under the direct supervision and guidance of a qualified person.

HEAT HAZARDS

Three major heat hazards in the science laboratory are Bunsen burners, alcohol burners and electric hot plates. To reduce the risk of burns, students should wear heat resistant gloves. Additional precautions are listed below.

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Bunsen Burners

Bunsen burners provide a direct and very efficient source of heat for laboratory purposes. However, there is a risk of direct burns to student fingers and hands. As well, if the burner is used to heat water or a solution, the rapid heating can cause boiling liquid to spurt out as it reaches boiling. To minimize risks:

- use Bunsen burners only if the activity requires high heat and if the maturity of the students is sufficient (in general, Bunsen burners would not be the preferred source of heat in elementary school and might be avoided in junior high school)
- provide students with training on the use of Bunsen burners, particularly the routine of lighting and regulating flame intensity
- supervise students closely at all times during use
- point the tube mouth away from anyone nearby when using Bunsen burners to heat a solution or water in a test tube
- do not use Bunsen burners or alcohol burners if flammable liquids are being used anywhere in the laboratory.

Alcohol Burners

Use of alcohol burners creates a significant burning hazard especially if there is any risk of the burner falling and breaking while it is lit. The use of hot plates in place of alcohol burners is thus recommended as it creates a lower risk for students. If alcohol burners are used, the following steps can be taken to minimize risks.

- Supervise students closely during use.
- Avoid moving alcohol burners while lit.
- Never use on sloping surfaces.
- Place the burner well away from the edge of the table or counter on which it is set.

Hot Plates

Electric hot plates with thermostatic controls provide a safer, controllable and reliable source of heat that meets the needs of science courses. However, they can still cause burns to skin. In addition, coiled hot plates, which might still be in use in some schools, have greater potential to cause burns because of the exposed coils. To minimize risks:

- ensure hot plates, as well as the heated materials and containers, are handled with care using proper techniques
- avoid coiled hot plates if possible, and take extra care if they must be used.

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ROCKETRY HAZARDS

Rockets are any devises containing combustible propellants that produce thrust by expelling hot gases. The major inherent risks associated with firing rockets include possible burns and the potentially lethal impact of misguided rockets. Safe construction and firing of model rockets requires a thorough knowledge of the regulations that control their design, the firing mechanism to be used, and where they may be launched. In addition, you must be a member of the Canadian Association of Rocketry (CAR) to launch rockets.

CAR has set out safety codes for regular and high-powered rockets, which can be accessed at http://www.canadianrocketry.org/. One must be thoroughly familiar with these codes before venturing into rocketry.

SOUND HAZARDS

Prolonged exposure to sound in excess of 85 decibels★ (dBA) causes permanent damage to inner ear hair cells, which results in deafness at the specific frequencies to which the lost hair cells were sensitive. Such volumes might be created, for example, by loud music at school dances or by large generators in mechanical rooms. By contrast, high impact noise causes eardrum perforation. Such noise is generated by pneumatic tools such as jack hammers. The eardrum perforations will heal, but each time this happens scar tissue builds up on the eardrum and makes it less and less sensitive to sound waves. Any equipment or instruments generating significant sound should be monitored for loudness to ensure they do not exceed allowable occupational exposure limits set out in the Occupational Health and Safety Code.

★**Note**: A dBA is a measure of sound level in decibels using a reference sound pressure of 20 micropascals when measured on the "A" weighting network of a sound level meter.

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CHAPTER 6

RADIATION HAZARDS

Radiation is an insidious hazard associated with electronic equipment such as cell phones, microwaves and X-ray machines, as well as radioactive material that might be used in the laboratory. In general, the levels of radiation one deals with in science activities are so low that they pose no real danger. However, potential hazards do exist and teachers should be familiar with the forms of radiation and their risks.

Radiation is the emission of energy from a substance, in either particulate or electromagnetic form. This energy can be reflected or absorbed or simply pass through a substance. Radiation and its hazards are generally classified into two distinct groups: ionizing and non-ionizing. The distinction lies in whether or not the radiation has the ability to strip electrons from atoms (to ionize in a medium in which the radiation is being absorbed). Because of the unique properties of these two classes of radiation, they are discussed separately.

Ionizing Radiation

With ionizing radiation, the process of ionization can break molecular bonds, which may cause cells to mutate, malfunction or die. Such interactions occur constantly as a result of exposure to normal background levels of ionizing radiation from cosmic rays and chemical agents. Two common forms of ionizing radiation that may be encountered in the laboratory are cathode rays and X-rays. Additional emissions of ionizing radiation from radioactive materials may include alpha and beta particles and gamma rays. However, the level of exposure from working with these sources in the school is extremely small and generally much less than accumulated exposure from normal background radiation. Thus, the associated risks are much lower than the health risks of everyday activities such as driving a car, swimming or cycling. As with any other classroom activities, however, it is the teacher's responsibility to ensure that equipment meets safety standards, is in good working order and is used appropriately.

Non-ionizing Radiation

Non-ionizing radiation interacts with human tissue in a fundamentally different way than ionizing radiation does. As its name implies, non-ionizing radiation does not ionize atoms or molecules, but it can increase their kinetic energy or "vibrate" them. That is, it can transfer radiation energy to tissues through heat production.

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The tissue-penetrating ability of non-ionizing radiation is related to its wavelength. When short wavelength radiation, like ultraviolet rays, is absorbed by the skin or eyes at a high enough intensity or for a long enough time, the result can be a burn-like reaction. Sunburns and painful "welder's flash" burns of the eye are familiar effects of exposure to ultraviolet radiation. In contrast to this acute type of injury, prolonged or chronic exposure to ultraviolet radiation can result in more serious effects such as premature skin aging or skin cancer.

At sufficiently high intensities, non-ionizing radiation can disrupt essential physiological processes. However, in normal school laboratory practices, where low intensity radiation sources are used and exposure is minimized, levels will be well below specified limits and it is generally not necessary to measure actual field strengths.

Protection from Non-ionizing Radiation

The best way to minimize the potential hazards of non-ionizing radiation is to limit exposure to radiation sources by taking precautions such as the following.

- Keep the time for potential exposure to a minimum.
- Stay as far from the radiation source as possible (note that this is not the case with laser beams, which do not significantly change in intensity within the space of a typical school laboratory).
- Use appropriate shielding or protection, such as UV goggles or protective gloves.
- Never look directly into a laser beam, ultraviolet radiation source or bright light.
- Instruct students in proper operating and handling procedures, and ensure that they follow these procedures.

Potentially Hazardous Sources of Non-ionizing Radiation

Ultraviolet radiation

Sources of ultraviolet rays in the classroom may include UV bulbs, welders, fluorescent bulbs, gas discharge tubes and burning magnesium ribbon. As already pointed out, ultraviolet rays are high energy rays that produce skin burns and "welders flash burns" of the eye with enough exposure and light intensity. To reduce these risks, minimize skin exposure and never look directly into a generator of ultraviolet rays without appropriate eye protection.

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Visible light and lasers
The direct or reflected viewing of any intense visible light source—electric arcs, burning magnesium ribbon, the Sun, or even collimated or focused beams from ordinary tungsten lights—can cause retinal damage. For example, looking at the Sun requires the use of a solar filter equivalent to that of a welding mask.

The visible beam of light from a laser is focused by the lens of the eye and can cause severe retinal damage with very brief exposure if the laser is of sufficient power. For this reason, the Canadian Radiation Emitting Devices Regulation specifies that demonstration lasers for educational institutions be limited to 1 milliwatt beam power and be within the wavelength range of visible light (400 to 780 nanometres).

For lasers meeting these criteria, the normal blink response time of 0.25 seconds is sufficient to prevent retinal damage. To further reduce risks:

- do not allow students to use lasers without close supervision
- use lasers in a well-lit room so that the pupils of the eye are small
- position lasers so that the beam cannot enter the eyes directly or by reflection.

Stroboscopes
Rhythmical pulses of light, especially in the range of 3 to 7 Hertz, can cause unpleasant or dangerous physiological effects in some people, including nausea and epileptic seizures. To minimize these risks:

- avoid the range of 3 to 7 Hertz
- warn students of potential effects and monitor them closely for unusual behaviour or onset of nausea during use of stroboscopes
- excuse students who know that flashing light has a negative effect on them.

Microwaves
All microwave ovens produced since 1971 are covered by a federal radiation standard that assures such ovens are safe. This standard limits leakage of microwaves to values well below the level at which heating or burning of human tissue would occur, even at distances as close as 5 cm.

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Chapter 7
Chemical Hazards

OVERVIEW

Chemical hazards come in a variety of forms. Some chemicals are toxic or corrosive in nature; others are unstable when exposed to certain compounds or conditions; still others are carcinogenic or mutagenic. Most of the chemicals used in schools do not pose serious dangers. However, there are some chemicals that require more careful handling and others that should be avoided altogether.

Before working with any chemical, particularly regulated or hazardous substances, teachers and students should be thoroughly familiar with its chemical and physical properties. The most important way to control risks is to limit exposure. One way of doing this is to remember that the dose makes the poison; in other words, the higher the concentration of a chemical the higher the toxic or corrosive hazard. At the same time, it is also important to know proper clean-up procedures, in case a spill does occur.

GENERAL SAFETY MEASURES

There are a number of general guidelines that can be followed to increase safety when working with chemicals.

- Ensure that the chemical is appropriately labelled and that the MSDS is readily available.
- Minimize exposure to chemicals.
- Ensure that the acquisition, use and storage of toxic materials are based on real needs: if safer alternatives exist, use them.
- Do not handle or use chemicals unless staff is WHMIS trained.
- Before using any chemical, review its MSDS to determine potential hazards.
- Inform students of hazards and the necessary safety precautions.
- Never underestimate risks when mixing chemicals.

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- Be prepared for accidents.
- Ensure chemicals and chemical wastes are stored with proper hazard identification.
- Do not keep stock bottles in the laboratory.
- Store chemicals in minimum quantities and in lower concentrations.
- Do not use toxic materials unless there is adequate protection from exposure.

MATERIAL SAFETY DATA SHEETS

Material safety data sheets (MSDSs) give detailed information about a chemical's composition, reactivity and health effects, as well as protective equipment, safety procedures and emergency procedures to use. These sheets must be prepared by the product supplier and provided to the user (in this case the school) for all controlled chemicals. Suppliers may also be asked for MSDSs for other chemicals they supply. The MSDSs supplied by a chemical supply company are the legal source of information for those chemicals in case of an accident. In addition to the MSDSs supplied by chemical supply companies, two good sources of MSDSs are http://www.msdssolutions.com and http://www.utoronto.ca.

MSDSs are an essential source of information about chemical hazards, so it is important that teachers and students be able to understand the sheets from a variety of suppliers. Although the numbering of sections and the order of appearance may differ from supplier to supplier, the following information must be on each MSDS:

I. PRODUCT IDENTIFICATION AND USE
Manufacturer's Name
Supplier's Name

II. HAZARDOUS INGREDIENTS

III. PHYSICAL DATA
Colour, form, solubility
Melting and boiling points
Vapour pressure, specific gravity

IV. FIRE AND EXPLOSION DATA
Flammability
Flashpoint
Fire fighting procedures

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V. REACTIVITY DATA
Stability and Hazards

VI. TOXOLOGICAL PROPERTIES
Threshold Limit Values (TLV)
Effects of exposure
Carcinogenicity

VII. PREVENTATIVE MEASURES
Protective Clothing
Protective Equipment
Spill and handling procedures

VIII. FIRST-AID MEASURES

IX. PREPARATION DATE OF MSDS

MSDSs are dated and expire at the end of a three-year period. Updating of MSDSs generally occurs in conjunction with the inventory update. Official MSDSs can be filed in hard copy form or on a computer, as long as they are readily available to all staff using these chemicals. Online access to specific company MSDSs may also be available, but this method requires tracking the chemicals and the companies from which each chemical was ordered if more than one supply company was used. For more information about chemical management, see Chapter 9.

TOXIC and CORROSIVE CHEMICALS

Toxic or corrosive properties are the most common hazards posed by chemicals in schools (see the Chemical Hazard Information Table in Chapter 8 for information about specific chemicals). A toxic substance is any substance that may cause damage by its chemical action when ingested, inhaled, absorbed or injected into the body in relatively small amounts. Damage can occur when materials:

- directly destroy tissue through corrosive action (e.g., NaOH reacts with moisture in the skin)
- interfere with chemical reactions of the body (e.g., CO replaces O_2 in hemoglobin)
- disrupt the biological processes of the body (e.g., NO_2 causes pulmonary edema and allergic responses).

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Exposure to Toxic Materials

Toxic materials can enter the body by:

- inhalation—breathing in poisonous or corrosive vapours and dust (most common route by which toxic materials enter the body)
- ingestion—swallowing liquid or solid toxic materials
- direct entry—chemicals entering through open wounds or directly injected through punctures, allowing chemicals access to the bloodstream
- contact—absorbing toxic materials through skin, mucous membrane or eyes.

Since inhalation of vapours or dust is the most common way that toxic materials enter the body, every effort should be made to avoid circumstances that allow this to happen. For example, powder forms of more toxic substances should be handled only in a fume hood.

Effects of Toxic Chemicals

Toxic effects can be local or systemic, acute or chronic. Local effects are confined to the area of the body that has come in contact with toxic materials; systemic effects occur throughout the body after absorption into the bloodstream. Acute effects are immediate and usually extremely serious or painful. With chemicals that can produce acute effects, poisoning may be suspected when any of the following are evident:

- strange odour on the breath
- discolouration of lips and mouth
- pain or burning sensation in the throat
- unconsciousness, confusion or sudden illness.

By comparison, chronic effects are long lasting and may take many years before becoming evident. Many substances, such as arsenic and mercury, have cumulative effects, meaning that poisoning may occur at lower concentrations through repeated exposures over a period of time. Such substances are sometimes known as insidious hazards.

Insidious substances include carcinogens, teratogens and mutagens. Carcinogens cause cancer in cells. Teratogens interrupt or alter the normal development of a fetus. These include chemicals such as ethanol and mercury compounds, viruses such as rubella, and ionizing radiation. Mutagens increase the rate of mutation of cells or organisms, and include chemicals such as nitrous acid, peroxides and dichromates, as well as certain viruses and radiation.

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Insidious Hazards

The most obvious source of insidious chemical hazards is from substances known to have dangerous long-term effects, such as mercury and carcinogens, which are discussed below. These substances can cause damage through direct exposure or through leakage of vapours or fumes from chemical containers. However, even if such chemicals are not intentionally ordered and stored in the schools, insidious hazards can still exist and be easily overlooked. These hazards include:

- leaking gas cylinders
- formaldehyde from biological specimens (if these are still around)
- mixed chemicals that slowly react to form toxic products, particularly mixtures of waste materials
- neglected containers of dried solutions and residues of chemical products from past demonstrations and activities
- residue from chemicals improperly disposed of in the sink drain, resulting in subsequent interactions that cause the formation and release of toxic or other hazardous materials into the laboratory air (for chemicals that can be safely disposed of down the drain, see the Chemical Hazard Information Table in Chapter 8).

Mercury

One relatively well-known insidious hazard is mercury, which can have serious and cumulative effects on the gastrointestinal and central nervous systems. Open mercury evaporates and readily absorbs through the skin and respiratory system. Disposal of mercury and mercury compounds is also a major concern.

Given the hazards of mercury, it is not recommended for use in Alberta schools. Mercury thermometers should no longer be used in schools because of potential breakages and spills. If mercury is still in stock, the following steps need to be taken to manage it more safely.

- Store mercury in plastic bottles under a layer of water or oil.
- Keep the container sealed in a cool, well-ventilated area.
- Avoid opening the container and allowing vapours to escape.
- Wear gloves when handling containers.

Mercury spills from thermometers, thermostats or any other source must be cleaned up immediately and thoroughly, regardless of the size of the spill. Unless spills are promptly and thoroughly cleaned up and the area decontaminated, dangerous exposure to vapours will continue. In the past, the common practice for clean-up was to aspirate or sweep up any visible drops. Often small droplets hidden in cracks and crevices were inadvertently left behind to evaporate into the atmosphere.

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Mercury droplets from 10 to 1000 micrometres in diameter also stick to vertical surfaces and penetrate into porous flooring. In some cases, relatively large amounts of mercury may be left undiscovered after spills. Prompt and thorough clean-up of mercury spills is essential or cumulative exposure to mercury vapours can cause irreparable harm to those working in the area.

In Alberta, the clean-up procedures for mercury spills in schools are determined by local school boards. Some boards may permit school staff to clean up spills using commercial spill kits, while others specifically restrict clean-up to professionals such as those at Hazmat Clean-Up. Check your school board's policy on mercury spill clean-up before proceeding with the actual process. If board policy allows staff clean-up, use a commercial spill kit that includes components to control vapours (i.e., aspirator, mercury absorbent and vapour absorbent).

Carcinogens

A carcinogen is a chemical, physical or biological substance that is capable of causing cancer. The damaging effects are subtle and imperceptible in the short run, thus carcinogenic substances are another insidious hazard that may be present in the laboratory and chemical storage area. A substance is considered to be carcinogenic if it has been evaluated and rated as a human carcinogen, an animal carcinogen or a potential carcinogen by the American Conference of Government Industrial Hygienists or the International Agency of Research on Cancer. These substances will also be categorized under WHMIS as Class D2.

Health Canada has tabled a list of substances assessed for carcinogenicity on its Web site at http://www.hc-sc.gc.ca/hecs-sesc/whmis/carcinogenesis.htm. The site also has links to the sites of agencies to enable searches of the most current information. Carcinogenic properties are also indicated in the Chemical Hazard Information Table in Chapter 8.

Actual manifestation of cancer or tumours for most carcinogenic chemicals requires prolonged and often relatively constant exposure. Proper storage of such chemicals in airtight containers reduces this hazard by limiting exposure only to periods of chemical usage. However, the more frequent the use, the greater the exposure, particularly for powdered forms of these chemicals, which can be absorbed through the skin and lungs.

Fewer chemicals have carcinogenic properties compared to other risks, and those that do should be avoided if possible. Whether to stock and use chemicals with carcinogenic properties will depend on curricular

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requirements, adequacy of facilities and the ability to safely handle these chemicals with the frequency required. Serious consideration should be given to using alternative chemicals wherever possible.

Corrosive Substances

Corrosive chemicals cause visible, usually rapid damage to human tissue at the site of contact. Often this corrosive quality is due to the reaction of the substance with water or moisture in the tissue. This is the case with strong acids and bases of 1M or greater concentration, non-metal halides, dehydrating agents, halogens and oxidizing agents. The most serious corrosion hazards come with substances that are in a mist or gaseous state, since they can be readily absorbed through the skin or inhaled into the lungs.

The corrosive properties of chemicals commonly found in schools are identified and discussed in the Chemical Hazard Information Table in Chapter 8.

Minimizing Risks of Toxic and Corrosive Chemicals

Whenever chemicals are used, the onus is on the teacher to assess risks, determine proper handling procedures and convey this information to students before beginning the activity. Handling procedures used for all chemicals, and especially those with greater hazards, should aim to minimize exposure. This can be accomplished through strategies such as the following.

- Do not handle hazardous materials in open container, as vapours, dust and liquids can easily escape during normal handling.
- Do not heat hazardous materials, as smoke and vapour may be released in much greater quantity when material is hot.
- Avoid crushing or grinding solids or unnecessarily transferring powders, which creates dust.
- Use and store hazardous materials only in areas without adequate ventilation. Toxic vapours can rapidly accumulate to dangerous levels in a room, or part of a room, that does not have a constant replacement of fresh air.
- Do not lean over open bottles, as toxic vapours can be concentrated directly above the bottle even in well-ventilated rooms.

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- Ensure chemicals are clearly labelled and check these labels every time a substance is used. Odours and appearance are not reliable guides to the toxicity of substances: dangerous liquids can be clear and odourless, and toxic vapours may have little or no odour, even at dangerous concentration levels.
- Use proper protective gear such as correct clothing, face protection, fume hoods or respirators to prevent skin contact with hazardous materials and inhalation of toxic vapours.
- Do not chew gum, smoke or store or consume food or beverages in an area where hazardous materials are used. Food, beverages and cigarettes can easily absorb hazardous vapours or be contaminated with unseen toxic dust. Poisons may also be transferred from hands to food or cigarettes.
- Follow proper clean-up procedures after each lab activity is finished. Substances left on benches or in beakers and bottles may expose others to these toxic materials.
- Ensure students wash their hands thoroughly after activities to avoid transferring toxic materials to food they eat.

Insidious hazards may be easily overlooked or ignored, even during routine safety inspections, because they do not have immediately obvious effects. To avoid or reduce these kinds of hazards, consider the following measures.

- Give specific attention to possible sources of insidious hazards during the safety inspection process.
- Prepare an inventory of insidious hazards that must be tended to regularly.
- Provide adequate ventilation in the form of hoods and forced air, as stated in current standards and codes.
- Avoid stock build-up of toxic, flammable or corrosive materials.
- Keep appropriate clean-up agents accessible in case of spills.
- Collect waste materials in separate containers and do not mix.
- Perform diligent and regular housekeeping.

OTHER CHEMICAL HAZARDS

Cryogenic Substances (liquefied/solidified gases)

Cryogenic substances are gases that are maintained in liquid or solid form at extremely low temperatures. The most common cryogens that are readily available to schools are solid carbon dioxide (dry ice) and liquid forms of hydrogen, oxygen, methane, nitrogen and fluorine.

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Cryogens pose several serious hazards. These include:

- *Explosive Pressure.* Cryogenic gas generates enormous pressure when it vapourizes within the container and when released through the valve. In the case of methane gas, for example, the expansion is 630 times that of the equivalent liquid volume.
- *Fire.* Flammable cryogenic substances present the same flammability hazard as their gaseous forms.
- *Embrittlement of structural materials and human tissues.* Most materials experience some degree of embrittlement at temperatures below -50°C. Contact with cryogenic liquids, their gases or the surfaces of their containers can lead to frostbite or more extensive freezing of tissue that can be very destructive. Living tissue can become completely frozen and so brittle that it will shatter on impact.
- *Asphyxiation.* Except for liquid oxygen, expansion of cryogens may displace a sufficient volume of air to cause asphyxiation. This is particularly true of dry ice, which sublimes into carbon dioxide gas and readily displaces normal air since it is heavier than other atmospheric gases.

The use of cryogenic compounds is not required to meet any specific learner outcomes in Alberta science curricula. Instead, teachers sometimes use these substances to create special effects. Use of cryogens may require submission of a written "Safe Work Procedure" proposal to the Safety Services Department or an equivalent department. Before proceeding with ordering and using these substances, check the regulation requirements with your board office.

Only personnel with the necessary expertise and appropriate administrative approval should handle compressed gases or cryogenic substances, including dry ice. Use by students is not recommended. Anyone choosing to use cryogens should have a thorough knowledge of the characteristics of the substance at the temperatures and pressures being used, and the appropriate safety precautions for handling. They should also know how to recognize and eliminate leaks, and the requirements for safe storage both short- and long-term.

To minimize risks, it is important to take every possible precaution, including the following.

- Use cryogens only in a properly ventilated space to avoid a build-up of gas that may cause fire, explosion or asphyxiation. Adequate ventilation is particularly important to prevent asphyxiation with the use of dry ice.
- Store containers of cryogenics in a cool, well-ventilated space, and vent containers properly to avoid explosion. Prolonged storage in a poorly ventilated area will cause metal valves to undergo chemical corrosion. If this occurs, store in a separate cool, dry room away from direct sunlight and sources of sparks or flame.

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- Ensure warning signs and the name of the cryogen are posted in locations where the substance is stored or used.
- Ensure vessels are appropriately labelled and filled only with the liquids that they were designed to hold.
- Perform operations slowly to minimize boiling and splashing.
- If liquid nitrogen is heavily contaminated with oxygen, handle it with precautions suitable for liquid oxygen. The appearance of a blue tint in liquid nitrogen is a direct indication of oxygen contamination.
- Take appropriate precautions when releasing cryogenic gases. If oxygen is used, remember that it does not burn but it does enhance burning of flammable materials, thus open flames or sources of sparks should be removed from the area.
- Ensure that all eyes are protected and all skin is covered by wearing goggles, a face shield, pants and boots, a laboratory coat or apron without pockets or cuffs, and loose-fitting gloves that can be easily removed.
- Remove watches, rings, bracelets and other jewelry.

Compressed Gases

Cylinders of compressed gases should be handled and stored in a similar fashion to cryogenic substances.

Containers used to store gases should meet the National Fire Protection Association (NFPA) standard.

Flammable Substances

Generally, substances that are highly flammable, particularly those that are also highly volatile, should not be used by students. If minute amounts are provided for student use, make sure the area is well ventilated and far from open flames or sparks. Try to identify and eliminate any unwanted ignition sources that may exist, such as sparks that come with unplugging electrical cords and static electricity. Teacher demonstrations using flammable substances can be done under similar conditions or under the fume hood.

Cabinets and containers used to store gases should meet the National Fire Protection Association (NFPA) standard.

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Explosive Substances

Concentrated forms of unstable substances that have the potential to explode pose too great a risk to warrant use and should not be kept in schools. Some explosive substances in lower concentrations, such as hydrogen peroxide, are relatively safe. Refer to this group in the table Reactive Nature of Chemicals in Chapter 8 for more information on explosive substances.

MANAGING the RELEASE or SPILL of toxic or corrosive substances

Deciding how to handle a spill first requires understanding the health hazards associated with the substance. The immediate questions that must be answered are:

- is this substance highly toxic or corrosive?
- does it give off toxic or corrosive fumes?
- are the fumes potentially explosive?

The answer to these questions requires some knowledge about the substance, which can be corroborated by the information in the Material Safety Data Sheet. In the Chemical Hazard Information Table found in Chapter 8 of this document, a highly toxic or corrosive substance has a Health Rating of 3 or 4. Release of highly toxic or corrosive substances, other than acids or bases, must be handled by specially-trained professionals equipped to deal with such emergencies. This will require evacuation of the school, particularly if toxic fumes are associated with the substance. See Chapter 2 for emergency procedures.

On the other hand, spills not involving highly toxic or highly corrosive substances should be dealt with immediately, using the guidelines provided below. Avoid the temptation to keep a general spill bin rather than disposing of each individual spill separately. Placing all spilled or waste chemicals in a general waste bin may cause reactions with paper, other contents or chemicals added later.

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Corrosive Liquids

Less serious spills of corrosive liquids can be handled using the following steps.

1. Put on protective clothing/equipment (face shield, rubber gloves, rubber boots and lab coat) if the spill is concentrated.
2. Contain the spill with asbestos-free vermiculite, clay cat litter (bentonite) or diatomaceous earth.
3. Neutralize the substance. For acids, liberally apply sodium bicarbonate (baking soda) or sodium carbonate (soda ash), or apply a spill kit pillow. For bases, sprinkle boric acid or citric acid on the spill, or apply a spill kit pillow. Test with pH paper to ensure the substance is completely neutralized.
4. Dilute with plenty of water and mop up using an absorbent cloth.
5. Wash contents down the sink and clean spill area with water. Wipe dry with paper towels.

Note: If a floor drain exists, it is usually permissible to wash the mixture down the drain with plenty of water, provided it is not prohibited by municipal by-laws or special waste regulations. Alternatively, absorbent materials (asbestos-free vermiculite or diatomaceous earth) may be used to soak up the solution. The resulting mixture can then be bagged, labelled and sent for disposal.

Flammable Liquids

Small amounts of solvents can be cleaned up as follows.

1. Immediately shut off all ignition sources and open windows and vents leading directly to the outside for ventilation.
2. Contain and cover the spill with a mineral absorbent such as asbestos-free vermiculite, bentonite or diatomaceous earth.
3. Scoop the contaminated absorbent into a heavy gauge garbage bag or plastic bucket with lid.
4. Wash the spill area with soap and water, using a disposable cloth.
5. Dispose of the contaminated cloth in the same garbage bag.
6. Allow to evaporate in the fume hood.

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Other Liquids (excluding mercury)

Water-soluble liquids:

If necessary, contain with towels, asbestos-free vermiculite, bentonite or diatomaceous earth.
Dilute with water.
Mop up using paper towels or cloths. Very small spills can be swabbed directly into a sink and flushed with large volumes of water.
Check the Chemical Hazard Information Table in Chapter 8 or the MSDS for final disposal details.

Water-insoluble liquids:

1. If necessary, contain with towels, asbestos-free vermiculite, bentonite or diatomaceous earth.
2. Cover the spill with mineral absorbent and scoop the contaminated material into a suitable container for disposal.
3. Wash the spill area with water and soap and wipe dry with paper towels.
4. Discard contaminated towels or cloth.
   Check the Chemical Hazard Information Table in Chapter 8 or the MSDS for final disposal details.

Solids

The critical factor in cleaning up solid chemicals is to avoid raising particles into the air and inhaling them.

1. Slowly sweep up granules or powder into a dustpan.
2. Mop up smaller amounts with a damp disposable cloth.
3. Wipe the area clean.
4. Determine appropriate disposal procedures from the Chemical Hazard Information Table in Chapter 8 or the MSDS.

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Chapter 8
Chemical Hazard Information

OVERVIEW

Many chemicals have minimal hazards, making them relatively safe to use; others pose inherent risks and require specific precautions for use. Still other chemicals must be handled with such extreme care that they are not practical or safe for use in schools. This chapter provides information on hazards for nearly 600 chemicals to help teachers, schools and districts select and use chemicals safely. Schools and jurisdictions may use this information as a starting point for reviewing chemicals currently on their shelves (particularly where chemicals have accumulated over the years) and reassessing the scope and contents of their chemical inventories.

The information in this chapter includes numeric ratings for health, flammability and reactivity, plus supplementary comments on the scope and severity of hazards. It also includes WHMIS and storage classifications, as well as transportation hazard classes and disposal methods. This information has been compiled from sources believed to be reliable, accurate and representative of the current knowledge at the time of writing. While every reasonable effort has been made to provide dependable information, neither the authors nor Alberta Learning can assume responsibility for the validity or completeness of all chemical references given or for the consequences of their use.

Inclusion of a chemical in this listing does not signal appropriateness for school use, but is provided as preliminary information on potential concerns. Given the nature and severity of hazards involved, some of the chemicals listed are designated as *not appropriate for use in schools due to safety considerations*. Readers are advised to consult MSDS sheets and other current sources of more detailed information before using any of the chemicals listed here. Omission from this list is also not an indication of safety.

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REACTIVE NATURE of CHEMICALS

Chemicals can be grouped according to their chemical properties and general behaviour on exposure to other substances or to certain conditions. The following table provides some information on types of reactive chemicals, which can be useful when designing a chemical storage scheme or deciding whether or not a chemical should be stocked for classroom use.

Reactive Nature of Chemical	Substances	Notable Characteristics	Handling and Storing
Explosive	• Fulminates* • Nitroglycerin* • Peroxides* • Picric acid* • Azides* • Perchlorates (Na, K)* • Hydrazines* • Dioxane* • Ether* (excluding petroleum ether)	• Substances that decompose with such speed that they cause a rapid expansion of air, sometimes accompanied by burning gases and flying objects. • Explosion may be caused by shock, friction or heat. • May form explosive by-products on slow decomposition during storage, e.g., ether and dioxane may form explosive peroxides with varying storage time. These appear as grey–green precipitates.	* Do not order, use or store **concentrates** of this group of chemicals in schools. • Lower concentrations of some explosive substances (e.g., hydrogen peroxide at 3% to 7%) are safe.
Acid sensitive	• Alkali metals • Alkaline hydroxides • Carbonates • Carbides • Nitrides • Metals • Sulfides • Cyanides*	• Substances that react with acids to release heat, hydrogen and/or other explosive gas and toxicants.	• Isolate from reactive substances. • Wear and use adequate protection.

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Reactive Nature of Chemical	Substances	Notable Characteristics	Handling and Storing
Water sensitive	• Strong acids and bases • Acid anhydrides • Alkali metals • Alkali metal hydrides • Carbides* • Aluminium chloride (anhydrous)	• Substances that react with water, releasing heat and/or flammable gases. • Ignition in moist air can cause explosions. • May produce acetylene or methane. • Spontaneous decomposition during extended storage may cause container to explode upon opening.	• Isolate from other reactive substances. • Store in cool, waterproof area. • Wear protective gear.
Oxidation-reduction sensitive (oxidizers only) .	• Oxygen • Mineral acids • Perchlorates* • Peroxides* (excluding H_2O_2) • Chromates and dichromates • Permanganates • Halogens and chlorates*	• Substances that undergo rapid oxidation or reduction releasing heat in the process. • Some are explosive.	• Isolate from each other and other potentially reactive substances. • Use adequate protection.
Special case–organic substances	• Acrolein* • Benzene* • Diethyl ether*	• Organic substances that are flammable, may polymerize violently or form explosive peroxides. • May explode when exposed to many oxidants. • May be carcinogenic (benzene).	• Store in an airtight container in a cool place. • Isolate from oxidants.
Pyrophors	• Phosphorous (white or yellow)*	• Substances that burn spontaneously when exposed to air.	• Protect from air.

* Chemicals that are not recommended for schools because of their **reactive** nature.

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ORGANIZATION of the chemical hazard information table

The Chemical Hazard Information Table in this chapter provides information to assist teachers and schools in deciding what chemicals to stock and use. The table lists hazard ratings for almost 600 chemicals, including a number of substances that have been used in schools in the past but that have serious risks associated with their use. As well, it provides additional information necessary for safe storage and disposal of the chemicals.

The absence of chemicals from this table does not imply that they are safe. Other sources should be consulted for information on these chemicals.

The Chemical Hazard Information Table is organized with the following column headings:

1. Chemical Name, State and Formula
2. Appropriateness for School Use
3. Hazard Ratings for Health, Flammability and Reactivity
4. Hazard Descriptions
5. WHMIS Hazard Classes
6. Chemical Storage Classes
7. TDG Hazard Classes
8. Chemical Disposal Methods

The content of each section, as well as the codes and conventions used in the table, is briefly explained below.

Chemical Name, State and Formula

The table lists chemicals alphabetically using names conforming with those of International Union of Pure and Applied Chemistry (IUPAC) and the Merck Index. Where an alternative name is acceptable, the substance will appear in the table under both names. The state of the substance is included since it implies concentration, a factor that must be known if the hazard levels are to be meaningful. The formula is provided as a means to cross-reference the names of substances, ensuring that the name used for a specific substance actually correlates with the correct substance by formula.

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Appropriateness for School Use

To assist teachers, schools and districts in making safe choices, the chemicals listed in the table have been grouped into one of three categories, based on their relative safety. The hazards of a chemical tend to increase with its concentration. Keeping this in mind, it should be noted that some chemicals in the table are rated in the "B" or "C" category in concentrated form, but may be rated in the "A" or "B" category in the dilute form. Many acids and bases are rated in this way. For example: Hydrochloric acid (HCl_{aq})

Concentration	Category
5% or less	A
above 5%	B

Category A – Chemicals appropriate for use in schools under controlled conditions of use.

Chemicals in this category are ones for which the risks can be managed if used in limited quantities and concentrations, in controlled situations and following safe procedures. Use of these chemicals should take into account the maturity and skills of the students, the knowledge and skills of the teacher, and the needs of the curriculum.

Category B – Chemicals not appropriate for student use in schools except in junior and senior high courses under highly controlled conditions of use.

This category of chemicals is not appropriate for use by students in elementary science, but may be appropriate for use in junior and senior high science courses when used in limited quantities under close supervision of well-qualified staff in appropriate facilities. If these chemicals are used, keep quantities and concentrations to a minimum, instruct students in safe use procedures, and ensure waste storage and disposal have been addressed. These chemicals may be appropriate for demonstration purposes in elementary schools by teachers with appropriate knowledge and skills.

Category C – Chemicals not appropriate for student use.

In general, chemicals are placed in this category pose a high degree of risk in one or more hazard categories (health, flammability or reactivity), making them potentially dangerous to use without extreme precautions. Conditions required for safe use by students exceed what can be consistently and reliably provided by schools. Some chemicals in this category may be used for demonstration purposes by well-qualified senior high school teachers following a thorough risk assessment.

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Hazard Ratings and Comments for Health, Flammability and Reactivity

Hazard ratings given in the Chemical Hazard Information Table are based on the National Fire Protection Association (NFPA) Hazchem Code, which is also used by most large North American chemical suppliers. This hazard identification system attaches numerical values to hazard levels for health, flammability and reactivity of a chemical. Each category of hazards is rated on a scale of 0 to 4 (low to high). In addition, a special precaution symbol may be used where necessary.

The five levels of each scale are generally defined quite narrowly, which makes it difficult to accurately assign ratings to some chemicals. This, in turn, contributes to the inconsistency in ratings that often is found in MSDSs from different supply companies, since some companies appear to factor in hazards associated with chronic or prolonged exposure while others do not. The ratings given in the Chemical Hazard Information Table have been cross-referenced with MSDS information from a variety of companies to ensure some consistency in hazard ratings and comments. The ratings also correlate closely with the descriptions and hazard comments shown in the summary charts below. For example, a health rating of 3 for a substance will always show as "corrosive" or "toxic" in the Hazard Comments section of the table.

It should be noted that the Health, Flammability and Reactivity scales are keyed to a narrowly defined set of hazards, which does not provide a complete picture of risks such as carcinogenicity or other long-term effects. Additional comments on hazards appear in the "Hazards" column and should be carefully noted. If there is doubt as to the potential hazard of a substance, additional sources or authorities should be consulted, such as the MSDS information sheets.

In most cases, the hazard ratings given are for the pure form of the chemical so that one can decide whether to handle the concentrate or to stock the solution, which in general will be safer to handle not only because the chemical concentration is reduced but also because inhalation of dust associated with powders can be avoided. In general, chemicals with a rating of 3 or 4 in one or more categories, but especially in health, are classified as inappropriate for student use. There are some exceptions to this rule, particularly in cases where the substance is provided in solution form that often presents a lower risk, particularly if the solution is dilute.

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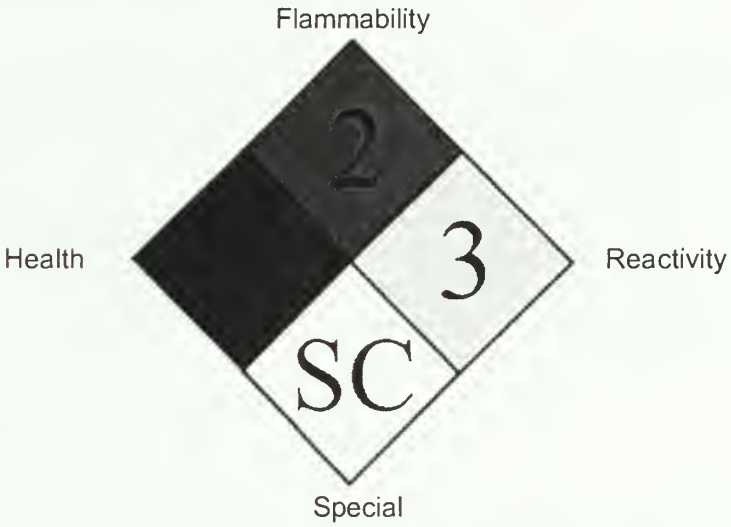
It should be noted that the Health, Flammability and Reactivity scales are keyed to a narrowly defined set of hazards, which does not provide a complete picture of risks such as carcinogenicity or other long-term effects. Carcinogenic substances and chemicals that react to produce toxic substance are often rated at a higher risk than is suggested by their numeric ratings. Additional comments on hazards that appear in the "Hazards" column should be carefully noted. If there is doubt as to the potential hazard of a substance, additional sources or authorities should be consulted such as the MSDS information sheets.

Sample NFPA Hazchem Code



Note: Colour-coding is not consistent among all manufacturers. Some omit colour entirely.

The three categories and five-point rating scale used in the NFPA Hazchem code are described in the Hazard Rating Chart below.

Health (Blue)		
4	**Danger**	May be fatal on short exposure. Specialized protective equipment required.
3	**Warning**	Corrosive or toxic. Avoid skin contact or inhalation.
2	**Warning**	May be harmful if inhaled or absorbed.
1	**Caution**	May be irritating.
0		No unusual hazard.

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4	**Danger**	Flammable gas or extremely flammable liquid.
3	**Warning**	Flammable liquid flash point below 100°F.
2	**Caution**	Combustible liquid flash point of 100° to 200°F.
1		Combustible if heated.
0		Not combustible.

Reactivity (Yellow)		
4	**Danger**	Explosive material at room temperature.
3	**Danger**	May be explosive if shocked, heated under confinement or mixed with water.
2	**Warning**	Unstable or may react violently if mixed with water.
1	**Caution**	May react if heated or mixed with water but not violently.
0	**Stable**	Not reactive when mixed with water.

Special Notice (White)	
W	Water Reactive
OX	Oxidizing Agent

Note: See http://www.nfpa.org/ for further information on the NFPA rating system.

WHMIS Hazard Classes

The Workplace Hazardous Materials Information System categorizes controlled substances into six classes and provides symbols for each of these. The classes are:

A. Compressed Gases
B. Flammable and Combustible Materials
C. Oxidizing Materials
D. Poisonous and Infectious Materials
   Division 1: Material causing immediate and serious toxic effects
   Division 2: Material causing other toxic effects
   Division 3: Biohazardous infectious material
E. Corrosive Materials
F. Dangerously Reactive Materials

This column of the Chemical Hazard Information Table shows which of these classes each chemical falls into. Substances that are not controlled are identified as NC on the table.

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For more information about WHMIS, refer to Chapters 1 and 9 and the Appendices.

Chemical Storage Classes

The chemical classes assigned in this section of the table and outlined below are useful in devising a scheme for the safe storage of chemical groups in laboratories or chemical storage rooms. In some cases, a chemical may fall into more than one class. In such instances, flammability is the primary overriding property for storage classification.

Refer to Chapter 9 for more details on this important aspect of chemical management.

Class #	Chemical Category and Symbol
1	Inorganic Acids (IA)
2	Strong Bases (SB)
3	Organic Acids (OA)
4	Flammable Solids (FS)
5	Flammable Liquids (FL)
6	Oxidizing Agents (OX)
7	Halogens (element form) (H)
8	Miscellaneous (M)

TDG Hazard Classes

The classes and divisions of chemicals defined by TDG regulations are important for a number of reasons, including the classification of chemical waste when preparing for disposal pick-up. The hazard classes are numbered 1 to 9. Certain classes are further subdivided into numbered divisions. The waste classification is followed by a point and the division number. For example, a classification of 4.3 means that the waste is in division 3 of class 4.

The table below briefly summarizes the nine classes and types of hazards involved. Refer to Part III of the *Transportation of Dangerous Goods Act and Regulations* for specifics about the criteria and procedures needed to determine hazardous waste classes, divisions and packing groups.

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Class 1 – Explosives	Explosives are classified into six divisions according to sensitivity and explosive potential. This class of compounds is not recommended for school use.
Class 2 – Gases	Class 2 substances can be a gas, a mixture of gases, a mixture of gases with one or more vapours of substances included in other classes, an article charged with a gas, an aerosol or tellurium hexafluoride. These substances fall into one of three divisions. **Divisions** 2.1 Flammable gases 2.2 Non-flammable, non-toxic gases 2.3 Toxic gases
Class 3 – Flammable liquids	This class includes liquids (or liquids containing solids in solution or suspension) that have a flashpoint less or equal to 60.5°C, or liquids that are intended or expected to be at a temperature that is greater than or equal to their flashpoint at any time while the substance is in transport.
Class 4 – Flammable solids	**Divisions** 4.1 Flammable solids 4.2 Substances liable to spontaneous combustion 4.3 Substances, which on contact with water, emit dangerous quantities of flammable gases
Class 5 – Oxidizing substances and organic peroxides	**Divisions** 5.1 Oxidizing substances 5.2 Organic peroxides
Class 6 – Toxic and infectious substances	**Divisions** 6.1 Toxic substances 6.2 Infectious substances
Class 7 – Radioactive materials	This class includes radioactive materials with an activity greater than 74 kBq/kg.

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Class 8 – Corrosive substances	This class includes materials that: ▪ cause full thickness destruction of human skin, i.e., lesions that are permanent and destroy all layers of the outer skin ▪ exhibit a corrosion rate that exceeds 6.25 mm/year at a temperature of 55°C.
Class 9 – Miscellaneous Products, Substances or Organisms	This includes any substance that does not meet the criteria for inclusion in classes 1 to 8 and contains one or more of the following: ▪ genetically modified micro-organisms that may endanger human life ▪ a marine pollutant ▪ material to be transported at high temperatures ▪ material that releases toxic substances through leaching ▪ environmentally hazardous substances.

Chemical Disposal Methods

The appropriate methods for disposing of various chemicals depends on a number of factors, and must meet federal, provincial and local regulations. The Chemical Hazard Information Table uses the following symbols to indicate disposal options for each chemical.

Symbol	Disposal Method	Comments
WF/I	Chemical Waste Facility/Incinerator (government approved)	Substances identified as controlled/hazardous products must be disposed of through a waste facility by federal/provincial law. Non-regulated chemical waste may be disposed via a waste facility.
A	Dissipate into Air	Atmospheric gases only.
D	Drain	Dilute acids and bases containing no regulated constituents (pH of 5.5 to 10) and non-hazardous, non-controlled salts can be disposed of this way.
R	Recycle	Local metal and plastic recycle depots.
N/P-T or N/P-D	Neutralize/Precipitate and Dispose of in Trash or Drain	Follow neutralization/precipitation procedure and dispose of non-toxic by-products in trash (T) or drain (D).
RS	Return to Supplier	Containers with remaining substance can be returned to supplier.
T	Trash (Landfill)	Dry, non-controlled, non-hazardous wastes.

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"Controlled products" are substances that fall into one or more of the WHMIS hazard classes. These include compressed gases, oxidizing materials and substances that are poisonous, infectious, flammable, combustible, corrosive or dangerously reactive. There is no master list of controlled products; however, any product with a hazard warning could be a controlled product.

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CHAPTER 8

CHEMICAL HAZARD INFORMATION TABLE

Note: One should become familiar with the background information to the Chemical Hazard Information Table in the introductory portion of this chapter before proceeding to the table for details on specific chemicals.

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
acetaldehyde --------- liquid (*ethanal, acetic aldehyde*) $CH_3CHO_{(l)}$ or $C_2H_4O_{(l)}$	C	3	4	2	Toxic; harmful by inhalation, ingestion, skin absorption, causes skin irritation or burns and severe eye irritation; affects the central nervous system, liver and kidneys; extremely flammable liquid and vapour, may form explosive levels of peroxides in storage; possible human carcinogen.	B, D1	5	3.1	WF/I
acetamide ---------- crystals (*acetic acid amide*) $CH_3CONH_{2(s)}$	C	1	1	0	May cause skin, eye and respiratory tract irritation; dust- air mixture explosive; possible human carcinogen.	D2	8	NR	WF/I
acetic acid, glacial -- liquid (*ethanoic acid*) $CH_3COOH_{(l)}$ or $C_2H_4O_{2(l)}$	B	3	2	0	Corrosive; liquid and mist cause severe burns to all body tissue; may be fatal if ingested; harmful if inhaled; flammable liquid and vapour.	B, E	5, 1	8 (3)	N/P -D
acetic acid ----------solution (*vinegar*) mixture: CH_3COOH ---------5 - 7% H_2O ---------- 93 -95% $CH_3COOH_{(aq)}$	A	1	0	0	Causes irritation of the nose, throat and respiratory tract, prolonged contact may cause burns and dermatitis.	NC	1	NR	N/P-D
acetic anhydride ----- liquid (*acetic oxide, ethanoic anhydride*) $C_4H_6O_{3(l)}$	C	3	2	1 W	Corrosive; causes severe burns to any area of contact; severe eye and respiratory irritant; harmful if swallowed; flammable liquid and vapour; water reactive.	D1, D2, E	5	8 (3)	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
acetone ---------- liquid (*2-propanone*) $CH_3COCH_{3(l)}$	B	1	3	0	Causes respiratory and eye irritation; vapours may cause drowsiness and dizziness causing depression of the central nervous system; harmful if swallowed; highly flammable.	B, D2	5	3	WF/I
aceto-carmine stain---------- solution mixture: carmine ---------- 0.5% acetic acid --------- 45.0% water ---------- 54.5%	B	1	0	0	May cause skin, eye and respiratory tract irritation; may cause gastro-intestinal tract discomfort if ingested.	D1, E	1	8	WF/I
aceto-orcein stain-solution mixture: acetic acid---------- 45% orcein ---------- 2% water ---------- 53%	B	1	0	0	May cause irritation to eyes, skin and respiratory system; may cause gastro-intestinal tract discomfort if ingested.	E	1	8	WF/I or N/P-D
acetyl chloride -------- liquid (*ethanoyl chloride*) $CH_3COCl_{(l)}$	C	3	3	2 W	Corrosive, causes severe burns to eyes and skin; harmful if inhaled or swallowed; highly flammable; reacts violently with water forming toxic phosgene.	B, D1	5	8 (3)	WF/I
acrolein ---------- liquid (*2-propenal, acrylaldehyde*) $C_3H_4O_{(l)}$	C	3	4	1	Corrosive; causes severe irritation or burns to eyes and skin; highly toxic if inhaled or ingested; highly flammable; may be carcinogenic.	B, D1, E	5	6.1	WF/I
acrylic acid ---------- liquid (*2-ropenoic acid*) $C_3H_4O_{2(l)}$ or $CH_2CHCOOH_{(l)}$	C	3	2	2	Toxic, may be fatal if swallowed; harmful if inhaled or absorbed through skin; causes burns to skin, eyes and mucous membranes; severe respiratory irritant; unstable, must be stored with MEHQ inhibitor and access to oxygen gas; flammable liquid and vapour.	B, D1, E	5	3 (8)	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
adipic acid --------- powder (*hexanedioic acid, 1,4-butandicarboxylic acid)* $C_6H_{10}O_{4(s)}$ or $HOCO(CH_2)_4COOH_{(s)}$	B	1	1	0	Causes irritation of the eyes; inhalation may cause irritation; powder-air mixture is explosive.	NC	3	NR	N/P - D
adrenaline ---------- powder (*epinephrine*) $C_9H_{13}NO_{3(s)}$	B	2	1	0	May cause irritation of eyes, skin, respiratory and digestive tracts; harmful by inhalation, contact with skin or if swallowed, excess absorption can be fatal; increases heart rate, blood pressure; powder-air mixture explosive.	D2	8	6.1	WF/I
agar, all culture --- powder mixture: agarose ---------- variable agaropectin-------- ‘ -glucose ---------- ‘ ascorbic acid ---- ‘ other ---------- “	A	2	1	1	May be irritating to eyes, skin, mucous membranes and upper respiratory tract; decomposes on exposure to light; combustible if heated or ignited.	NC	8	NR	T
L-alanine ---------- crystals (l-2 aminopropanoic acid) $C_3H_7NO_{3(s)}$ or $CH_3CH(NH_2)COH_{(s)}$	B	1	1	0	Dust may cause irritation of eyes, digestive and respiratory tracts; flammable if heated, combustible if heated or ignited, powder-air mixture is explosive.	NC	8	NR	T or D (aq)
alizarin ---------- crystals (*alizarin B or red, mordant red 11, turkey red*) $C_{14}H_8O_{4(s)}$	B	2	1	0	Skin and eye irritant; may be harmful if ingested or inhaled; flammable if heated, powder-air mixture explosive.	D2	8	NR	T or D (aq)
alizarin red S------ solution mixture: alizarin ---------- 1.0% water ---------- 99.0%	B	1	0	0	Solution may cause mild skin and eye irritation.	NC	8	NR	D

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
alizarin red S ----- powder (*mordant red 3*) $C_{14}H_7NaO_7S_{(s)}$	B	2	1	0	May cause severe irritation of skin, eyes, digestive and respiratory tracts; harmful if swallowed or inhaled; combustible if heated or ignited, powder-air mixture is explosive	NC	8	NR	T or D (aq)
alizarin yellow R -- powder $C_{13}H_8NaO_5N_{3(s)}$	B	2	1	0	Causes severe eye and skin irritation, irritating to the mucous membranes and upper respiratory tract; may be harmful if swallowed or inhaled; combustible if heated or ignited, dust-air mixture explosive.	NC	8	NR	T or D (aq)
alum ---------- powder (*aluminium potassium-sulfate dodecahydrate*) $KAl(SO_4)_2 \cdot 12H_2O_{(s)}$	A	2	0	0	Causes irritation of skin, eyes and respiratory tract; harmful if swallowed or inhaled.	D2	8	NR	WF/I or N/P-T
aluminon ---------- crystals (*ammonium aurintricarboxylate*) $C_{22}H_{23}N_3O_{9(s)}$	B	2	1	0	Causes minor irritation of the skin and eyes; harmful by ingestion or inhalation; flammable if heated.	D2	8	NR	T or D (aq)
aluminium ----- foil or strips $Al_{(s)}$	A	0	1	0	Metal strips or foil has no adverse effects; strips will readily burn if ignited.	B	8	NR	R or T
aluminium --------- powder $Al_{(s)}$	B	1	1	1 W	Metal powder may be irritating to eyes and respiratory system; not readily absorbed through skin, digestive tract or the lungs; chronic exposure may cause lung damage; powder readily burns or explodes if ignited; reacts slowly with water to liberate H_2.	B	8	NR	R or T

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
aluminium acetate (basic)----- powder mixture: $Al(C_2H_3O_2)_2OH_{(s)}$ ------ 30% $Al_2O_{3(s)}$ ---------- 70%	A	1	1	0	Nuisance dust, may cause irritation to eyes, skin and respiratory tract; may be harmful if swallowed or inhaled; dust-air mixture explosive.	NC	8	NR	T or D
aluminium ammonium-sulfate dodecahydrate ---- powder (*ammonium alum*) $AlNH_4(SO_4)_2 \bullet 12H_2O_{(s)}$	A	1	0	0	May cause eye, skin, respiratory and/or digestive tract irritation. Prolonged exposure may cause liver damage.	NC	8	NR	T or D (aq)
aluminium carbide ---------- powder $Al_4C_{3(s)}$	C	1	3	1	Causes irritation of eyes, mucus membranes and upper respiratory tract; highly flammable solid; contact with water liberates extremely flammable gases.	B	4	4.3	WF/I
aluminium carbonate ---------- powder $Al_2(CO_3)_{3(s)}$	A	0	0	0	No adverse effects.	NC	8	NR	T or D (aq)
aluminium chloride, anhydrous ---------- powder $AlCl_{3(s)}$	C	3	0	2 W	Corrosive; causes irritation and burns to skin, eyes, respiratory and digestive tracts; reacts violently with water forming HCl.	D2, E, F	8	8	WF/I or N/P-T
aluminium hydroxide ---------- powder (*aluminium hydrate*) $Al(OH)_{3(s)}$	A	1	0	0	Causes irritation of eyes and respiratory tract.	NC	2	NR	WF/I or N/P-T
aluminium nitrate nonahydrate ------- crystals $Al(NO_3)_3 \bullet 9H_2O_{(s)}$	B	2	0	0 ox	Causes irritation of skin, eyes and respiratory system; harmful if ingested or inhaled; strong oxidizing agent.	C, D1, D2	6	5.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
aluminium oxide -- powder $Al_2O_{3(s)}$	A	2	0	0	May irritate eyes and respiratory system; may be harmful if swallowed or inhaled.	NC	8	NR	T
aluminium phosphate --------- powder $AlPO_{4(s)}$	C	3	0	0	Corrosive; causes skin and eye burns and severe damage to digestive tract if ingested; causes severe irritation and possible burns to mucous membranes of respiratory tract if inhaled.	D1, E	8	NR	WF/I
aluminium potassium sulfate dodecahydrate----- crystals (*alum*) $AlK(SO_4)_2 \bullet 12H_2O_{(s)}$	A	2	0	0	Causes irritation of skin, eyes and respiratory tract; harmful if swallowed or inhaled.	D2	8	NR	WF/I or N/P-T
aluminium sodium sulfate ---------- powder $NaAl(SO_4)_{2(s)}$	A	1	0	0	May cause mild irritation of the skin, eyes, respiratory and digestive tracts if inhaled or ingested.	NC	8	NR	WF/I or N/P-T
aluminium sulfate- powder $Al_2(SO_4)_{3(s)}$	A	2	0	0	May irritate skin; severe eye irritant; harmful if inhaled, ingested or absorbed through skin.	E	8	NR	WF/I or N/P-T
aluminium sulfide-granules $Al_2S_{3(s)}$	C	1	0	2 W	Irritating to skin, eyes and mucous membranes; reacts violently with water and acid-producing toxic H_2S.	F	8	4.3	WF/I
ammonia, anhydrous---------- gas (liquid under pressure) $NH_{3(g)}$ & $NH_{3(l)}$	C	3	1	0	Corrosive liquid and gas; irritating and causes burns to eyes and skin; may cause burns if ingested or inhaled; flammable vapour, air-gas mixture explosive.	E	2, 8	2.2 (8)	WF/I
ammonia water---- solution (*household ammonia*) mixture: NH_3 ---------- 10% H_2O ---------- 90% $NH_{3\,(aq)}$	A	2	0	0	Irritating to skin and mucous membranes; may cause burns with prolonged exposure; harmful if swallowed; absorbed through skin or with inhalation of fumes.	E	2, 8	8	N/P-D

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
ammonia water---- solution (*ammonium hydroxide*) mixture: NH_3 ---------- 25 - 30% H_2O ---------- 70 - 75% $NH_{3\,(aq)}$	B	2	1	0	Irritating to skin and mucous membranes; may cause burns with prolonged exposure; harmful if swallowed; absorbed through skin or with inhalation of fumes; vapours flammable, concentrated air-gas mixture explosive.	E	2, 8	8	N/P-D
ammonium acetate ---------- crystals $CH_3COONH_{4(s)}$	B	1	1	0	May cause irritation to eyes, skin, digestive and respiratory tracts; flammable if heated or ignited, particle-air mixture explosive.	D2	8	NR	T or D (aq)
ammonium bromide---------- crystals $NH_4Br_{(s)}$	A	2	0	0	Causes irritation of skin, eye and mucous membranes of the respiratory tract; harmful by ingestion, inhalation or inhalation; affects the central nervous system and eyes.	D2	8	NR	T or D (aq)
ammonium carbonate ---------- powder $(NH_4)_2CO_{3(s)}$	B	2	0	2	Causes irritation of skin, eye and respiratory tract; harmful if swallowed or inhaled; unstable upon exposure to air, converts to ammonium bicarbonate.	D2	8	NR	T or D (aq)
ammonium chloride---------- powder $NH_4Cl_{(s)}$	A	2	0	0	Irritating to skin, eyes and respiratory tract; harmful if swallowed or inhaled.	D2	8	NR	T or D (aq)
ammonium chromate ---------- crystals $(NH_4)_2CrO_{4(s)}$	C	3	0	0 ox	Corrosive; causes severe irritation, burns to skin, eyes and mucous membranes; may be fatal by ingestion, inhalation or skin absorption; strong oxidizing agent, may explode when heated; mutagen; human carcinogen.	D1, D2, C, E	6	9	WF/I
ammonium citrate--powder $(NH_4)_2HC_6H_5O_{7(s)}$	B	2	1	0	May cause irritation to skin, eyes and respiratory tract; harmful if ingested or inhaled; flammable if heated or ignited, particle-air mixture explosive.	NC	8	NR	T or D (aq)

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
ammonium dichromate --------- crystals $(NH_4)_2Cr_2O_{7(s)}$	C	3	1	1 ox	Corrosive; causes severe skin and eye irritation and burns to any area of contact; toxic by inhalation or ingestion; very strong oxidizing agent; combustible solid if ignited, also decomposes if heated; known human carcinogen.	D1, D2, C, E	6	5.1	WF/I or N/P-T
ammonium dihydrogen-phosphate ---------- crystals (*ammonium phosphate monobasic*) $NH_4H_2PO_{4(s)}$	B	2	0	1	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled.	NC	8	NR	WF/I
ammonium ferrous sulfate hexahydrate ------- crystals (*mohr's salt, ammonium iron(II)sulfate hexahydrate*) $(NH_4)_2FeSO_4{\cdot}6H_2O_{(s)}$	B	2	1	0	May cause irritation of the skin, eyes, respiratory and intestinal tracts; may be harmful by inhalation or skin absorption; ingestion may cause iron poisoning, larger intakes can cause liver and kidney damage and other complications; unstable, air and light sensitive.	D1	8	9	WF/I or N/P-T
ammonium fluoride ---------- crystals $NH_4F_{(s)}$	C	3	0	0	Corrosive; causes severe burns to skin, eyes, respiratory and digestive tracts; may be fatal by ingestion, inhalation or skin absorption; symptomatic effects may be delayed without sensation or onset of pain.	E	8	6.1	WF/I
ammonium hydrogen carbonate ---------- powder (*ammonium bicarbonate*) $NH_4HCO_{3(s)}$	A	1	0	0	Mildly irritating to eyes and respiratory membranes; ingestion can cause nausea and vomiting.	NC	8	NR	T or D (aq)
ammonium hydrogen-phosphate ---------- crystals (*ammonium phosphate, dibasic*) $(NH_4)_2HPO_{4(s)}$	B	2	0	0	Causes skin and eye irritation; may damage cornea; causes respiratory and intestinal tract irritation.	NC	8	NR	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
ammonium hydroxide ---------- solution (*ammonia water*) mixture: NH_4OH ---------- 57% H_2O ---------- 43% (NH_3 ---------22% - 30%)	B	3	1	0	Corrosive; causes severe burns to skin, eyes and gastro-intestinal tract, if ingested; inhalation causes severe irritation and inflammation of respiratory membranes; concentrated fumes explosive.	E	2	8	N/P-D
ammonium molybdate tetrahydrate -------- crystals $(NH_4)_6Mo_7O_{24}{\cdot}4H_2O_{(s)}$	B	2	0	0	Causes irritation to skin, eyes and respiratory tract; may be harmful if swallowed or inhaled; extended exposure affects kidneys and blood.	NC	8	NR	T or D (aq)
ammonium nitrate–crystals $NH_4NO_{3(s)}$	B	2	0	3 OX	Causes irritation to skin, eyes and respiratory tract; may be harmful if swallowed or inhaled; strong oxidizer; may decompose if heated; will explode if heated to 210°C; explodes more readily if contaminated with combustible material.	C, D2	6	5.1	WF/I
ammonium oxalate monohydrate ----- granules $(NH_4)_2C_2O_4{\bullet}H_2O_{(s)}$	C	4	1	0	Toxic and corrosive; inhalation may be fatal due to spasm, inflammation and edema; extremely destructive to tissue of the mucous membranes and upper respiratory tract; causes severe burns to skin, eyes and gastro-intestinal tract, if ingested; may affect kidneys; combustible if heated or ignited.	E	8	8	WF/I
ammonium sulfate-crystals $(NH_4)_2SO_{4(s)}$	A	2	0	0	Skin, eye and respiratory irritant; may be harmful by inhalation, ingestion or skin absorption.	D2	8	NR	T or D (aq)

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
ammonium sulfide -- liquid $(NH_4)_2S_{(l)}$	C	3	3	1	Corrosive; strong skin, eye and mucous membrane irritant; causes burns to any area of contact; may be fatal if swallowed or inhaled; harmful if absorbed through skin; highly flammable liquid and vapour; toxic hydrogen sulfide gas is released when heated.	B, D2	5	8 (3) (6.1)	WF/I
ammonium sulfite monohydrate ------ crystals $(NH_4)_2SO_3 \bullet H_2O_{(s)}$	B	2	0	0	Causes irritation of eyes, skin, mucous membranes and upper respiratory tract; may be harmful by inhalation, ingestion or skin absorption.	NC	8	NR	T or D (aq)
ammonium thiocyanate -------- crystals $NH_4SCN_{(s)}$	B	2	0	1	May cause irritation of skin, eyes and/or respiratory tract; harmful if swallowed, inhaled or absorbed through skin; emits toxic fumes when heated or in contact with acids.	NC	8	NR	T or D (aq)
ammonium thiosulfate ---------- powder $(NH_4)_2S_2O_{3(s)}$	B	2	0	1	Irritating to skin, eyes and respiratory system; harmful if inhaled, swallowed or in contact with skin; decomposes and emits toxic gases when heated to temperatures above 220°F.	NC	8	NR	T or D (aq)
ammonium vanadate ---------- granules $NH_4VO_{3(s)}$	C	3	0	0	Highly toxic fume, mist and dust; may be fatal if inhaled or ingested; causes irritation to skin, eyes and respiratory tract; may damage lung tissue and bronchial airways.		8	6.1	WF/I
amyl acetate ---------- liquid (*n-amyl acetate*) $CH_3COOC_5H_{11(l)}$	C	2	3	0	Causes irritation to the eyes, skin and respiratory tract; harmful if swallowed or inhaled; highly flammable liquid and vapour.	B, D1	5	3	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
iso-amyl alcohol ---- liquid (*isopentyl alcohol*) $C_4H_{10}O_{(l)}$ or $(CH_3)_2CHCH_2CH_2OH_{(l)}$	B	2	2	0	Causes irritation to skin, mucous membranes and respiratory tract; severe irritant to eyes; harmful if swallowed, inhaled or ingested; hematotoxic; affects the central nervous system; flammable liquid and vapour; emits toxic fumes when burned.	B, D2	5	3	WF/I
n-amyl alcohol ------ liquid (*1-pentanol, n-pentyl alcohol*) $C_5H_{11}OH_{(l)}$	B	2	3	0	Liquid causes skin and severe eye irritation with possible burns; vapours cause severe irritation of the respiratory tract; harmful if inhaled, swallowed or absorbed through skin; affects the nervous system; flammable liquid and vapour.	B, D2	5	3	WF/I
amylase ---------- powder composition- variable	B	1	1	0	May cause irritation of skin, eyes and respiratory tract; low ingestion hazard; dust-air mixture explosive.	NC	8	NR	T or D (aq)
aniline ---------- liquid (*amino benzene, benzenamine*) $C_6H_5NH_{2(l)}$	C	3	2	0	Toxic; may be fatal by ingestion, inhalation and skin absorption; causes irritation to skin and respiratory tract; severe irritant to eyes; combustible liquid and vapour; mutagen.	B, D1	5	6.1	WF/I or N/P-D
antimony ---------- solid $Sb_{(s)}$	B	2	1	0	Dust causes skin, eye, digestive and respiratory irritation; prolonged exposure may cause blood abnormalities and cardiac disturbances; inhalation of fumes causes metal-fume fever; chronic inhalation may cause liver, kidney and cardiac changes; bulk metal combustible at high temperatures; dust-air mixture is explosive.	D1, E	8	6.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
antimony pentachloride --------- liquid (*antimony perchloride*) $SbCl_{5(l)}$	C	3	0	1 W	Corrosive; liquid causes severe burns to skin and eyes; extremely destructive to tissues of the mucous membranes and upper respiratory tract; may be fatal if ingested, inhaled or absorbed through skin; water reactive.	D1, E	8	8	WF/I
antimony sulfate---------- powder (*diantimony trisulfate*) $Sb_2(SO_4)_{3(s)}$	B	2	0	1	May cause skin, eye and/or respiratory tract irritation; harmful if swallowed, inhaled or absorbed through skin; chronic exposure may cause liver and kidney damage; decomposes if heated.	D2	8	6.1	WF/I
antimony sulfide ---------- powder (*diantimony trisulfide*) $Sb_2S_{3(s)}$	B	2	1	0	Causes irritation of skin, eye and mucus membranes of upper respiratory tract; harmful if inhaled, ingested or absorbed through skin; possible carcinogen; particle-air mixture explosive.	D2	8	NR	WF/I
antimony trichloride ---------- crystals (*trichlorostibine*) $SbCl_{3(s)}$	C	3	0	1 W	Corrosive; contact with skin and eyes causes severe irritation or burns; harmful if inhaled, ingested or absorbed through skin; inhalation of dust may cause dizziness and difficulty breathing; ingestion causes nausea, vomiting and loss of consciousness; water reactive, releases heat and toxic fumes.	E	8	8	WF/I
antimony trioxide-- crystals (*diantimony trioxide*) $Sb_2O_{3(s)}$	B	2	1	0	Causes irritation to skin, eyes, digestive and respiratory tracts; harmful if swallowed or inhaled; prolonged exposure affects the cardiovascular system and liver; powdered form flammable if heated; mutagen.	D2	8	6.1	WF/I

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apatite ---------- crystalline (*fluorapatite, chlorapatite, hydroxlapatite*) $Ca_5(PO_4)_3 \cdot F/Cl/OH_{(s)}$	A	1	0	0	Dust may cause irritation of skin, eyes, respiratory and digestive tracts.	NC	8	NR	T
L(+) arabinose ---- crystals (*pectin sugar*) $C_5H_{10}O_{5(s)}$	A	0	1	0	No adverse effects; flammable if heated; flammable if heated or ignited, dust-air mixture explosive.	NC	8	NR	T
L-arginine ---------- powder $C_6H_{14}N_4O_{2(s)}$	A	0	1	0	No adverse effects; flammable if heated or ignited.	NC	8	NR	T
argon ---------- gas $Ar_{(g)}$	A	2	0	0	Argon is non-toxic but may produce suffocation by displacing the oxygen in the air.	NC	8	NR	A
arsenic --- powder or lump $As_{(s)}$	C	4	1	0	Very strong neurotoxin; may be fatal if powder inhaled, or if swallowed, or absorbed through the skin; known human carcinogen; may cause reproductive disorders; dust-air mixture is slightly explosive.	D1	8	6.1	WF/I
arsenic pentoxide- powder (*diarsenic pentaoxide*) $As_2O_{5(s)}$	C	3	0	0	Toxic by inhalation and /or ingestion; mutagen; may be a human carcinogen.	D1, D2	8	6.1	WF/I
arsenic trichloride --- liquid (*trichloroarsine*) $AsCl_{3(l)}$	C	3	0	0	Toxic; may cause skin, eye, respiratory and digestive tract irritation; may be fatal if swallowed; may cause cardiac disturbances and/or liver and kidney damage; may cause central nervous system depression; human carcinogen.	D1, D2	8	6.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
arsenic trioxide ---- powder (*diarsenic trichloride*) $As_2O_{3(s)}$	C	3	0	0	Toxic; causes skin and eye irritation; causes severe respiratory and digestive tract irritation or burns; highly toxic by ingestion and inhalation; may cause lung damage and cause central nervous system effects; may have adverse reproductive and fetal effects; human carcinogen.	D1, D2	8	6.1	WF/I
asbestos —--- fibrous solid mixture: silicates of Na, Mg and Ca; most commonly chrysotile - $Mg_3(Si_2O_5)(OH)_4$ amosite $(MgFe)_7(Si_8O_{22})(OH)_{2(s)}$	C	1	0	0	Causes irritation of the eyes, nose and throat; prolonged inhalation of particles cause asbestosis and cancer.	D2	8	9	WF/I
ascorbic acid ------ crystals (*vitamin C*) $C_6H_8O_{6(s)}$	A	1	1	0	May cause mild irritations of the skin, eyes and respiratory tract; flammable if heated or ignited.	NC	3	NR	T or D (aq)
L-asparagine monohydrate ------ crystals $C_4H_8O_3N_2 \bullet H_2O_{(s)}$	A	0	1	0	No adverse effects; flammable if heated or ignited.	NC	8	NR	T
L-aspartic acid ---- crystals $C_4H_7NO_{4(s)}$	A	0	1	0	No adverse effects; flammable if heated or ignited.	NC	3	NR	T
azure A ---------- powder $C_{14}H_{14}ClN_3S_{(s)}$	A	2	0	0	May cause irritation of the eyes, skin and respiratory system; may be harmful if swallowed or inhaled.	NC	8	NR	T
azure B ---------- powder (*azure I*) $C_{15}H_{16}ClN_3S_{(s)}$	A	2	0	0	May cause irritation of the eyes, skin and respiratory system; may be harmful if swallowed or inhaled.	NC	8	NR	T

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baking soda ------- powder (*sodium hydrogen carbonate or bicarbonate*) $NaHCO_{3(s)}$	A	1	0	0	May cause slight irritation of the eyes, skin and respiratory tract.	NC	8	NR	T or D (aq)
barium —- powder or solid $Ba_{(s)}$	C	3	1	2 W	Toxic; poisonous if powder inhaled or ingested; reacts violently with water and acids; flammable if heated.	D1, F	8	4.3	WF/I
barium carbonate--powder $BaCO_{3(s)}$	B	2	0	0	May cause irritation of the skin, eyes, and respiratory tract; harmful if inhaled; may be fatal if swallowed; prolonged exposure affects muscles and central nervous system; may cause kidney damage.	D1	8	6.1	N/P-T or WF/I
barium chloride dehydrate ---------- solid $BaCl_2 \bullet 2H_2O_{(s)}$	C	3	0	0	Toxic; may cause irritation to skin, eyes and respiratory tract; may be fatal if swallowed, harmful if inhaled; prolonged exposure affects heart, respiratory system and central nervous system.	D1, D2	8	6.1	N/P-T or WF/I
barium iodide ------ beads $BaI_{2(s)}$	B	2	0	0	Irritant to eyes, skin and mucous membranes; harmful if inhaled or swallowed; chronic exposure can cause severe gastroenteritis, slow or irregular heartbeat.	D2	8	6.1	N/P-T or WF/I
barium(IV) oxide -- powder (*barium peroxide*) $BaO_{2(s)}$	C	3	0	1	Toxic; skin or eye contact may lead to severe irritation or burns; may be fatal if swallowed; chronic exposure may lead to damage to CNS, spleen, liver, kidney and/or bone marrow; decomposes slowly in the presence of water.	D1, D2	8	6.1	WF/I

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barium hydroxide - crystals (*barium hydrate*) $Ba(OH)_{2(s)}$	B	3	0	0	Toxic; causes irritation of the skin, eyes and respiratory tract; may be fatal if swallowed, harmful if inhaled; prolonged exposure affects muscles and central nervous system.	D1, E	2	6.1	N/P-T or WF/I
barium iodide ------ crystals $BaI_{2(s)}$	B	2	0	0	Causes irritation of the skin, eyes and mucous membranes; harmful if inhaled or swallowed; ingestion causes severe abdominal pain, vomiting, diarrhea, tremors and slow or irregular heartbeat.	D1	8	6.1	N/P-T or WF/I
barium nitrate ----- crystals *(black ash)* $Ba(NO_3)_{2(s)}$	B	3	0	0 OX	Toxic; causes irritation of the skin, eyes and respiratory tract; may be fatal if swallowed, harmful if inhaled; prolonged exposure affects muscles and central nervous system; strong oxidizer, may cause fire if in contact with reducing agents or combustibles.	C, D1, D2	6	5.1 (6.1)	WF/I
barium sulfide ---- crystals $BaS_{(s)}$	B	2	1	1	Irritates and burns skin and eyes; harmful by ingestion or inhalation; acute over-exposure may be fatal; causes hair loss; decomposes when heated to produce toxic gas, particle-air mixture is combustible.	D1, D2	8	6.1	WF/I
bauxite -- chunks/granules mixture: aluminium silicates & oxides of Al, Si, Ti & Fe	A	1	0	0	Can cause mild irritation to skin, eyes, respiratory and digestive tracts; silicates known to be carcinogenic in humans with prolonged exposure.	NC	8	NR	T

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Benedict's qualitative reagent ---------- solution mixture of: H_2O ---------- 73.5% $NaCO_3$------- 10.0%, $CuSO_4$------- 1.5%, $NaC_6H_5O_7$--- 15.0%	B	2	0	0	Causes severe irritation of the skin and eyes, as well as the respiratory and digestive tract if ingested or inhaled; long-term exposure may corrode the digestive tract with hemorrhaging and shock, may cause liver and kidney damage or cause adverse reproductive and fetal effects.	D2	8	6.1	WF/I or N/P-D
benzaldehyde ------- liquid (*benzoic aldehyde*) $C_6H_5CHO_{(l)}$	B	2	2	0	Causes irritation of the skin, eyes and respiratory tract; harmful if swallowed or inhaled; prolonged exposure may cause central nervous system depression that can lead to unconsciousness, coma and possible death due to respiratory failure; combustible liquid.	B, D1, D2	5	NR	WF/I
benzaldehyde green ---------- crystals (*malachite green hydrochloride*) $C_{23}H_{25}ClN_{2(s)}$	B	2	1	1	Contact with skin or eyes may cause irritation; ingestion may be harmful; flammable if heated; light sensitive.	NC	8	6.1	WF/I
benzene ---------- liquid $C_6H_{6(l)}$	C	3	3	0	Toxic; causes irritation of the skin, eyes and respiratory tract; toxic by ingestion, inhalation and skin absorption, depresses the central nervous system; highly flammable; human carcinogen.	B, D1, D2	5	3	WF/I
benzenesulfonic acid 1.5 hydrate --------- crystals (*phenylsulfonic acid*) $C_6H_5SO_3H \bullet 1.5H_2O_{(s)}$	C	3	0	0	Corrosive; causes burns to any area of contact; harmful if swallowed, inhaled or absorbed through the skin.	E	3	8	WF/I

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benzoic acid ------ crystals (*benzenecarboxylic acid, phenylformic acid)* $C_7H_6O_{2(s)}$	A	2	1	0	Causes moderate irritation of the skin and severe irritation and possible injury to eyes; may be harmful if swallowed, inhaled or absorbed through skin; combustible if heated.	D2	3	NR	T
benzoyl peroxide - crystals *(dibenzoyl peroxide, acetoxyl, nericur)* $(C_6H_5CO)_2O_{2(s)}$	C	2	3	3 ox	Irritant of skin, eyes and respiratory tract; harmful if swallowed or inhaled; possible mutagen and carcinogen; highly flammable; strong oxidizer, reaction with reducing compounds can cause fire; extremely explosive, sensitive to shock, friction and heat.	B, C, D2, F	4,6	5.2	WF/I
beryllium metal ------- lump $Be_{(s)}$	C	3	1	0	Very toxic if swallowed or inhaled; irritating to skin, eyes and respiratory system; human carcinogen.	D1, D2	8	NR	WF/I
beryllium salts ---------- crystals	C	3 or 4			Very toxic; human carcinogens.	D1, D2	-	-	WF/I
bile salts --------- powder (oxgall) formula not applicable	A	1	0	0	Causes irritation to skin, eyes and respiratory tract; may cause allergic reaction if sensitive to proteolytic enzymes.	NC	8	NR	T
bismuth ---------- powder $Bi_{(s)}$	A	2	1	0	May cause irritation of the skin, eyes, digestive and respiratory tracts; prolonged exposure affects the central nervous system; may cause liver and kidney damage; powder flammable.	NC	8	NR	T
bismuth chloride pentahydrate ------ crystals (*bismuth trichloride*) $BiCl_3 \bullet 5H_2O_{(s)}$	A	2	0	1	Causes irritation to skin, eyes and respiratory tract, may cause burns; decomposes in water to form bismuth oxychloride.	NC	8	NR	T

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bismuth nitrate ---- crystals *(bismuth ternitrate)* $Bi(NO_3)_{3(s)}$	B	2	0	0 ox	Causes irritation to skin, eyes and respiratory tract, harmful if swallowed; strong oxidizer, reaction with reducing agents or combustibles may cause ignition.	C	6	5.1	WF/I
bismuth oxide ----- powder *(dibismuth trioxide, bismuth yellow)* $Bi_2O_{3(s)}$	A	0	0	0	No adverse effects.	NC	8	NR	T
Biuret reagent ----- solution mixture: $NaOH$ ----- 28.00% $CuSO_4$ ----- 0.12% H_2O -------- 71.88%	A	2	0	0	Corrosive; harmful by inhalation, ingestion or skin absorption; causes burns of the skin, eyes, respiratory and digestive tract; irritation may lead to chemical pneumonitis and pulmonary edema.	D2, E	2	8 (6.1)	D
bleach ---------- solution (*sodium hypochlorite*) mixture: H_2O ----------80 – 99% NaClO---------- 1 – 20% $NaClO_{(aq)}$	B	2	0	2 ox	Skin irritant, may cause burns to skin and eyes; harmful by inhalation, ingestion or through skin contact; light and temperature sensitive, decomposes with release of chlorine gas; oxidizer.	C, D1	6	8	D
bleaching powder ---------- granules (*calcium hypochlorite*) $Ca(ClO)_{2(s)}$	B	3	0	1 ox W	Corrosive to eyes; minute amounts very harmful if ingested, extremely toxic if inhaled into lungs, burns mucous membranes; water reactive, emits toxic chlorine gas; rapidly decomposes on exposure to air; thermally unstable; oxidizer, decomposes at 180°C releasing oxygen.	C, D1, E	6	8	D (aq) WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
borax ---------- powder (*sodium borate decahydrate*) $Na_2B_4O_7 \bullet 10H_2O_{(s)}$	A	2	0	0	May cause irritation of skin, eyes and respiratory tract; harmful if inhaled or ingested.	NC	8	NR	T or D (aq)
boric acid ---------- crystals $H_3BO_{3(s)}$	A	2	0	0	May cause skin, eye and respiratory tract irritation; causes severe digestive tract irritation resulting in hemorrhaging and shock; may have adverse reproductive affects.	D2	1	NR	T or D(aq)
boron ---powder or chunks $B_{(s)}$	C	3	3	0	Toxic by inhalation, ingestion or by skin absorption; irritant; may affect the CNS; highly flammable.	B, D1, D2	4	4.1	WF/I
brass ---------- solid mixture: copper---- variable (2 parts) zinc ------- variable (1 part) other metals -- variable	A	1	0	0	Finished alloy is not hazardous. Dust or fume is classified as skin and eye irritant.	C, D1	8	NR	R
bromine ------- liquid & gas $Br_{2(l)}$ or $Br_{2(g)}$	C	3	0	0 OX	Highly toxic by skin contact, inhalation or ingestion; severe skin irritant, causes severe burns; very strong oxidizer; reacts violently with many organic compounds.	D1	6,7	8 (6.1)	WF/I or N/P-D
bromine water – solution $Br_{(aq)}$	B	3	0	0 OX	Corrosive vapour or mist; may cause irritation or severe burns to skin, eyes or respiratory tract; ingestion may cause digestive tract burns, abdominal pain, vomiting and possible death; oxidizer.	C, D1	6,7	8 (6.1)	WF/I or N/P-D

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bromcresol green---------- powder $C_{21}H_{14}Br_4O_5S_{(s)}$	A	2	1	0	May cause irritation of skin, eyes and respiratory tract; may be harmful if swallowed or inhaled; dust-air mixture explosive.	NC	8	NR	T
bromcresol green ---------- solution mixture: water ---------- >98.8% bromcresol green----------< 1.O% tetrasodium ethylene diamine tetraacetate ---------0.02%	A	1	0	0	May cause irritation of skin, eyes.	NC	8	NR	D
bromcresol purple----------powder $C_{21}H_{16}Br_2O_5S_{(s)}$	A	2	0	0	May cause irritation of skin, eyes and respiratory tract; may be harmful if swallowed, inhaled or absorbed through skin.	NC	8	NR	T
bromcresol purple---------- solution mixture: water ---------- 99.96% bromcresol purple—0.04% $C_{21}H_{16}Br_2O_5S_{(aq)}$	A	1	0	0	May cause irritation of skin and eyes.	NC	8	NR	D
bromoethane--------- liquid (*ethyl bromide*) $C_2H_5Br_{(l)}$	C	2	3	0	A skin, eye and respiratory tract irritant; harmful if swallowed or inhaled, chronic exposure may lead to liver and kidney damage; an anaesthetic and a narcotic; highly flammable, low flash point, forms explosive mixtures with air; possible carcinogen, mutagen.	B, D2	5	6.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
bromophenol ------ powder $C_6H_5BrO_{(s)}$	A	1	1	0	Causes irritation to skin, eyes, gastrointestinal and respiratory tracts; flammable if heated or ignited.	NC	8	6.1	WF/I
bromophenol blue–powder $C_{19}H_{10}Br_4O_5S_{(s)}$	A	2	1	0	May cause irritation to skin, eyes and respiratory tract, may be harmful if swallowed or inhaled; flammable if heated, particle-air mixture explosive.	D1	8	6.1	T or D(aq)
4-bromophenol blue ---------- solution mixture: water ---------- 79.- % methyl alcohol ------ 20.0% bromophenol blue- < 1.0%	A	2	1	0	May cause irritation to skin, eyes and respiratory tract; may be harmful if swallowed or inhaled; flammable vapours.	D1	8	6.1	D
bromothymol blue ---------- solution mixture: water ---------- 99.9% bromothymol blue- 0.1%	A	1	0	0	May cause irritation to skin and eyes.	NC	8	NR	D
bromothymol blue–crystals $C_{27}H_{28}Br_2O_5S_{(s)}$	A	2	1	0	May cause irritation to skin, eyes and respiratory tract; harmful if swallowed; flammable if heated, particle-air mixture explosive.	D1	8	NR	T
butane ---- liquefied gas $C_4\ H_{10(l)}$ & $C_4\ H_{10(g)}$	B	1	4	0	Eye and skin irritant, may be harmful if ingested, inhaled or through skin contact; can cause CNS depression; extremely flammable.	A, B	5	2.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
1-butanol ---------- liquid *(butyl alcohol, propyl carbinol, n-butyl alcohol)* $C_4H_{10}O_{(l)}$ or $CH_3(CH_2)_2CH_2OH_{(l)}$	B	2	3	0	May cause irritation to skin, eyes and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; affects the CNS, may affect liver and kidneys; highly flammable liquid and vapour.	B, D2	5	3	WF/I
2-butanone ---------- liquid *(methyl ethyl ketone)* $C_4H_8O_{(l)}$ or $CH_3COCH_2CH_{3(l)}$	C	2	3	0	Vapour an eye and skin irritant; may be harmful by ingestion, inhalation or through skin contact; prolonged exposure causes CNS depression, may cause damage to lungs and CNS; may be a mutagen; highly flammable.	B, D2	5	3	WF/I
iso-butyl alcohol ----- liquid (*2-methyl-1-propanol*) $C_4H_{10}O_{(l)}$ or $(CH_3)_2CHCH_2OH_{(l)}$	B	2	3	0	Causes irritation of the skin, eyes and mucous membranes; may be harmful if swallowed, inhaled or absorbed through skin; prolonged exposure affects the CNS, may damage the liver and kidneys; highly flammable.	B, D2	5	3	WF/I
sec-butyl alcohol ---- liquid (*2-butanol, 1-methyl propanol)* $C_4H_{10}O_{(l)}$ or $CH_3CHOHCH_2CH_{3(l)}$	B	2	3	0	Causes irritation to skin, eyes and respiratory tract, harmful if swallowed or inhaled; affects the CNS; highly flammable liquid and vapour.	B, D2	5	3	WF/I
butyl alcohol-tert ----- liquid *(tert-butanol, 2-methyl-2-propanol)* $C_4H_{10}O_{(l)}$ or $(CH_3)_3COH_{(l)}$	B	2	3	0	May cause irritation to eyes and respiratory tract, may cause irritation to skin; harmful if swallowed or inhaled; affects the CNS, may affect liver and kidneys; highly flammable liquid and vapour.	B, D2	5	3	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
n-butyl phthalate --- liquid (butyl phthalate) $C_6H_4 (CO_2 C_4H_9)_{2(l)}$	B	2	1	0	Causes skin and respiratory tract irritation and severe eye irritation; harmful if swallowed or inhaled; combustible if heated or ignited.	D2	8	9	WF/I
n-butyric acid --------- liquid *(butanoic acid,ethyacetic acid, propylformic acid)* $C_4H_8O_{2(l)}$ or $CH_3CH_2CH_2COOH_{(l)}$	B	2	2	0	Causes severe irritation and possible burns to skin and eyes, may cause respiratory tract irritation; harmful if swallowed, inhaled or absorbed through skin; obnoxious odour; flammable liquid and vapour.	B, E	5,3	8	WF/I
cadmium metal -- solid bar $Cd_{(s)}$	A	2	0	0	No special health hazards except for dust that may be released. For cadmium powder (dust), see below.	D1, D2	8	NR	R
cadmium metal --- powder $Cd_{(s)}$	C	3	1	0	Toxic by skin contact, inhalation or ingestion; may be fatal if inhaled; prolonged exposure causes damage to lungs and kidneys; dust-air mixture explosive; probable human carcinogen.	D1, D2	8	6.1	WF/I
cadmium carbonate ---------- powder $CdCO_{3(s)}$	C	3	0	0	Toxic by inhalation, skin contact or by ingestion; may cause eye and skin irritation; prolonged exposure may cause lung and kidney damage; probable human carcinogen with prolonged exposure.	D1, D2	8	6.1	WF/I
cadmium iodide -- crystals $CdI_{2(s)}$	C	3	0	0	Toxic; inhalation or ingestion may be fatal; excessive or prolonged inhalation of dust may be severely damaging to the respiratory passages and/or lungs, as well as the kidneys and liver; probable human carcinogen dependent on duration and level of exposure.	D1, D2	8	6.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
cadmium nitrate -- powder $Cd(NO_3)_{2(s)}$	C	3	0	1 OX	Toxic; causes severe burns to skin, eyes and respiratory tract; may be fatal if swallowed or inhaled; can cause lung and kidney disease; strong oxidizer, contact with combustible materials may cause fire; carcinogenic with prolonged exposure.	C, D1	6	6.1	WF/I
caffeine ---------- powder (1,3,7-trimethylxanthine) $C_8H_{10}N_4O_{2(s)}$	B	2	1	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled; may cause birth defects; flammable if heated, particle-air mixture explosive.	D1, D2	8	6.1	WF/I
calcite ---------- crystalline (*calcium carbonate*) $CaCO_{3(s)}$	A	0	0	0	May cause irritation to skin, eyes and respiratory tract; nuisance dust.	NC	8	NR	T
calcium metal -------- solid $Ca_{(s)}$	B	3	1	2 ~~W~~	Corrosive; contact may cause burns; harmful or fatal if swallowed or absorbed through skin; flammable solid; reacts with water.	B, E	8	4.3	WF/I
calcium acetate --- powder $Ca(CH_3COO)_{2(s)}$	A	0	0	0	No adverse affects.	NC	8	NR	T or D (aq)
calcium carbide - granules $CaC_{2(s)}$	C	2	4	3 ~~W~~	Causes severe skin and eye irritation; harmful if inhaled; unstable; extremely flammable; reacts violently with water liberating flammable acetylene gas.	B, D2	4	4.3	WF/I
calcium carbonate-powder (*calcite, aragonite, limestone*) $CaCO_{3(s)}$	A	1	0	0	May cause irritation to skin, eyes and respiratory tract; nuisance dust.	NC	8	NR	T or D (aq)

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
calcium chloride - granules (*dowflake*) $CaCl_{2(s)}$	A	2	0	0	Causes irritation and possible burns to skin, eyes and respiratory tract; harmful if swallowed or inhaled; releases chlorine fumes when heated.	D2	8	NR	T or D (aq)
calcium dihydrogen-phosphate monohydrate ------ crystals (*calcium phosphate monobasic*) $Ca(H_2PO_4)_2 \bullet H_2O_{(s)}$	A	1	0	0	Direct contact with eyes causes severe irritation or burns; may cause respiratory tract irritation.	NC	8	NR	WF/I
calcium fluoride --- powder (*fluorite, acid spar*) $CaF_{2(s)}$	A	2	0	0	May cause irritation to skin, eyes and respiratory tract; may be harmful if swallowed or inhaled.	E	8	NR	T or D (aq)
calcium hydride - granules $CaH_{2(s)}$	C	3	2	2 W	Corrosive; contact may cause burns; harmful if swallowed, inhaled or absorbed through skin; strong reducing agent; highly flammable solid; reacts with water.	B, D1, E	4	4.3	WF/I
calcium hydroxide-crystals (*slake lime, calcium hydrate*) $Ca(OH)_{2(s)}$	B	3	0	0	Corrosive; causes burns to skin and eyes and severe irritation to respiratory tract; harmful if swallowed or inhaled.	E	2	8	T or D (aq)
calcium hydroxide-solution mixture: H_2O ----------80 – 90% $Ca(OH)_2$ ---------- 10 –20% $Ca(OH)_{2\ (aq)}$	A – 5% or less B – more than 5%	3	0	0	Corrosive; causes burns to skin and eyes and severe irritation to respiratory tract; harmful if swallowed or inhaled.	E	2	NR	D
calcium hypochlorite —------ crystals (*bleaching powder*) $Ca(ClO)_{2(s)}$	B	3	0	1 ox W	Corrosive; causes burns to area of contact; harmful if swallowed or inhaled; strong oxidizer; reacts with water; emits toxic chlorine gas when mixed with acid.	C, D1, E	6	5.1	D (aq) WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
calcium nitrate tetrahydrate -------- crystals $Ca(NO_3)_2 \bullet 4H_2O_{(s)}$	C	2	0	3 ox	Causes irritation to skin, eye and respiratory tract; harmful if swallowed or inhaled; strong oxidizer; will ignite reducing agents or combustibles; may be explosive by shock or friction.	C, D2, F	6	5.1	WF/I
calcium oxide ----- powder $CaO_{(s)}$	B	3	0	1 W	Corrosive; contact causes severe burns to skin, eyes and respiratory tract if inhaled; may cause alkali burns to mouth and throat if ingested; reacts with organic materials and water.	E	8	NR	WF/I
calcium oxalate monohydrate ------- powder $CaC_2O_4 \bullet H_2O_{(s)}$	A	2	0	0	May cause irritation of skin, eye, respiratory and digestive tracts; harmful if swallowed or absorbed through skin.	D1	8	6.1	WF/I
calcium phosphate (dibasic)dihydrate- crystals $CaHPO_4 \cdot 2H_2O_{(s)}$	A	0	0	0	May cause irritation of skin, eyes and respiratory tract.	NC	8	NR	T or D (aq)
calcium phosphate (tribasic) ---------- crystals $Ca_3(PO_4)_{2(s)}$ or $Ca_5(OH)(PO_4)_{3(s)}$	A	1	0	0	May cause irritation of skin, eyes, respiratory and digestive tracts.	NC	8	NR	WF/I
calcium propionate -------- granules $Ca(CH_3CH_2COO)_{2(s)}$	A	1	0	0	May cause irritation of skin, eyes, respiratory and digestive tracts, if large amounts ingested.	NC	8	NR	WF/I
calcium sulfate -- granules (*anhydrous gypsum*) $CaSO_{4(s)}$	A	1	0	0	Causes irritation to skin, eye and respiratory tract; may be harmful if swallowed.	NC	8	NR	WF/I

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calcium sulfide ---- powder $CaS_{(s)}$	C	3	1	1	Toxic; may be fatal if inhaled or ingested; irritant to skin and mucous membranes; flammable, oxidizes in dry air, decomposes in moist air to form H_2S, oxides of sulfur, calcium hydroxide, CO_2 and CO.	D1	8	NR	WF/I
camphor ---------- crystals (*2-bornanone*) $C_{10}H_{16}O_{(s)}$	A	1	2	0	Causes irritation to skin, eye and respiratory tract; flammable.	B	4	4.1	T
caprylic alcohol---------- liquid (*n-octanol*) $C_8H_{18}O_{(l)}$ or $CH_3(CH_2)_6CH_2OH_{(l)}$	B	2	2	0	Causes irritation to skin, eye and respiratory tract, may be harmful if swallowed or inhaled; affects the CNS; combustible liquid and vapour.	B, D1	5	NR	D
carbamide ---------- powder (*urea*) $CH_4N_2O_{(s)}$ or $NH_2CONH_{2(s)}$	A	1	1	0	May cause irritation of skin, eyes, respiratory and digestive tracts; particle-air mixture explosive.	NC	8	NR	T or D (aq)
carbolic acid ------liquid or crystals (*phenol, phenic acid, phenylic acid*) $C_6H_6O_{(s)}$	C	4	2	0	Toxic and corrosive; absorbed rapidly through skin; causes severe burns to any area of contact; may be fatal if swallowed, inhaled or absorbed through skin, affects CNS, liver and kidneys; flammable.	B, D1, D2	4 ,5,3	6.1	WF/I
carbon ----------powder (*graphite*) or rods $C_{(s)}$	A – rods B – powder	1	1	0	Dust may cause mechanical skin and eye irritation, may cause irritation of the respiratory and digestive tracts; flammable, dust-air mixture explosive.	NC	8	4.2	T
carbon dioxide --------- gas $CO_{2(g)}$	A	2	0	0	Will elevate rate of breathing and heart rate; gas non-toxic but displaces oxygenated air and can cause rapid suffocation with high concentrations.	NC	8	2.2	A

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carbon disulfide ----- liquid (*carbon bisulfide*) $CS_{2(l)}$	C	3	4	0	Toxic; may be fatal if inhaled or ingested; harmful if absorbed through skin; affects the CNS and heart, may cause liver and kidney damage; has adverse reproductive and fetal effects; extremely flammable liquid and gas.	B, D1, D2	5	3 (6.1)	WF/I
carbon tetrachloride–liquid $CCl_{4(l)}$	C	3	2	0	Toxic; may be fatal by inhalation or skin absorption, highly toxic by ingestion; causes irritation to skin, eyes and respiratory tract; readily absorbed through skin; reproductive toxin; flammable, emits toxic fumes; mutagen and possible human carcinogen.	D1, D2	5	6.1	WF/I
carborundum --------- solid (*silicon carbide*) $SiC_{(s)}$	A	1	0	0	May cause mechanical irritation to skin and eyes and irritation to the respiratory and digestive tracts; chronic inhalation of dust may lead to silicosis and lung damage.	NC	8	NR	T
carmine ---------- powder $C_{22}H_{20}O_{13}•xAl_{(s)}$	A	2	0	0	May cause skin, eye and respiratory tract irritation; may be harmful if swallowed, inhaled or absorbed through skin.	NC	8	NR	WF/I
Carnoy's fluid --------- liquid mixture: ethanol---------- 98.0% acetic acid (glacial)- 1.0% chloroform ---------- 1.0%	C	1	3	0	May cause irritation to skin, eyes and respiratory tract, possible burns to eyes; ingestion may cause discomfort and vomiting; highly flammable liquid.	B, D1, D2	5	3	WF/I
casein ---------- granules (*milk protein)* formula not applicable	A	0	1	0	No adverse health effects; flammable if heated or ignited.	NC	8	NR	T

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caustic potash ------ pellets (*potassium hydroxide*) $KOH_{(s)}$	B	3	0	1	Corrosive; causes severe burns to any area of contact; harmful by ingestion, inhalation or skin contact; unstable, absorbs carbon dioxide and moisture from air.	D1, E	2	8	WF/I or N/P-T
caustic soda -------- pellets (*sodium hydroxide*) $NaOH_{(s)}$	B	3	0	1	Corrosive; causes burns to any area of contact, may be fatal if swallowed; harmful if inhaled; heat released when added to water.	D1, E	2	8	WF/I or N/P-T
cellulose acetate –powder (variable formula)	A	1	1	0	No adverse effects.	NC	8	NR	T or D (aq)
cellulose methyl ether---------- granules (*methyl cellulose*) $C_7H_{14}O_5X$ (X-variable)$_{(s)}$	A	0	0	0	No adverse effects.	NC	8	NR	T
cesium metal ---------- solid $Cs_{(s)}$	C	2	0	2 W	May cause irritation of skin, eyes, respiratory and digestive tracts; may cause central nervous system effects, cardiac disturbances; reacts violently with water.	D1, D2, F	8	4.3	WF/I
cesium chloride -- crystals $CsCl_{(s)}$	A	0	0	0	No adverse effects.	NC	8	NR	T
cetyl alcohol ------- powder (*1-hexadecanol, palmityl alcohol*) $C_{16}H_{34}O_{(s)}$ or $CH_3(CH_2)_{14}CH_2OH_{(s)}$	A	1	1	0	May cause mild skin and eye irritation; powder-air mixture flammable.	NC	8	NR	T
chalcopyrite -------- chunks (*cupric ferrous sulfide*) $CuFeS_{2(s)}$	A	1	0	0	May be irritating to skin, eyes and respiratory tract; prolonged exposure may cause hemolysis of the red blood cells and injury to liver, lungs, kidneys and pancreas.	NC	8	NR	T

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charcoal ----------solid (*carbon*) $C_{(s)}$	A	1	1	0	Dust may cause mechanical skin and eye irritation, may cause irritation of the respiratory and digestive tracts; flammable.	NC	8	4.2	T
chlorine ---------- gas $Cl_{2(g)}$	C	4	0	0 ox	Extremely toxic if inhaled; strong oxidizer.	D1, D2	6, 7	5.1	WF/I
chloroform ---------- liquid (*trichloromethane*) $CHCl_{3(l)}$	C	2	0	0	Causes irritation to skin, eyes and respiratory tract; may be fatal if swallowed, inhaled or absorbed through skin; extended exposure may affect the CNS, cardiovascular system, liver and kidneys; possible human carcinogen.	D1, D2	8	6.1	WF/I
2 -chlorophenol ------ liquid (*o-chlorophenol, 2-hydroxychlorobenzene*) $C_6H_5ClO_{(l)}$	C	3	2	0	Corrosive; very destructive of mucous membranes, inhalation may be fatal; harmful if swallowed or absorbed through skin; may cause liver and kidney damage; flammable; possible human carcinogen.	B, D1, D2	5	5	WF/I
chromic acid ----- solution (*chromium(VI)) oxide solution*) mixture: H_2O ---------- 90% CrO_3 ---------- 10% $CrO_{3(aq)}$	C	3	0	1 ox	Corrosive; causes burns to skin, eyes and mucous membranes; highly toxic; powerful oxidizing agent; avoid contact with reducing agents and organic material. A human carcinogen as fume or dust.	C, D1, D2, E	1, 6	8	N/P-D
Chromium (III) acetate ---------- powder (*chromic acetate*) $C_6H_9CrO_{6(s)}$ or $Cr(CH_3COO)_{3(s)}$	B	1	1	0	May cause minor irritation of skin, eyes and respiratory tract; prolonged exposure causes cumulative lung damage; combustible if heated or ignited.	NC	8	6.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
chromium(III) chloride hexahydrate ------- crystals $CrCl_3 \cdot 6H_2O_{(s)}$	B	2	0	0	May cause skin, eye, respiratory and digestive tract irritation and possible burns; may be harmful if swallowed; may cause liver and kidney damage; may cause fetal effects.	NC	8	NR	WF/I
chromium(III) nitrate nonahydrate ---------- solid $Cr(NO_3)_3 \cdot 9H_2O_{(s)}$	B	2	0	1 OX	May cause severe skin, digestive and respiratory tract irritation and possible burns; may cause methemoglobinemia; strong oxidizer, may explode when heated.	C, D2	6	5.1	WF/I
chromium metal ------ solid $Cr_{(s)}$	A	1	0	0	Associated dust may cause irritation to skin, eyes and respiratory tract. For dust, see effects below.	NC	8	NR	R
chromium metal -- powder $Cr_{(s)}$	B	2	1	1	Dust causes skin, eye and digestive tract irritation; causes severe respiratory tract irritation; may cause lung, liver and kidney damage; oxidizes in air; dust-air mixture explosive.	NC	8	NR	R
chromium(III) chloride hexahydrate ----- powder $CrCl_3 \cdot 6H_2O_{(s)}$	B	2	0	0	Causes skin and eye irritation and possible burns, causes respiratory tract irritation; may cause digestive tract irritation, may cause kidney and liver damage with prolonged exposure.	D1, D2	8	6.1	WF/I
chromium(III) nitrate nonahdrate --------- crystals $Cr\ (NO_3)_3 \cdot 9H_2O_{(s)}$	B	2	0	1 OX	Irritant to skin and eyes with possible burns; harmful if swallowed or inhaled; strong oxidizer, may explode when heated.	D1	6	5.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
chromium(VI) oxide ---------- powder $CrO_{3(s)}$	C	3	0	1 ox	Corrosive; causes severe burns to every area of contact, harmful if swallowed or inhaled, affects the respiratory system, liver, kidneys, eyes, skin and blood; strong oxidizer; carcinogenic	D1, D2	6	5.1, 8	WF/I
chromium potassium sulfate•12 hydrate----------granules $CrK(SO_4)_2 \cdot 12\ H_2O_{(s)}$	A	2	0	0	Causes skin, eye and respiratory tract irritation; harmful if swallowed or inhaled.	D2	8	NR	WF/I
citric acid ---------- powder $C_6H_8O_{7(s)}$	B	2	0	0	Causes skin and respiratory tract irritation; causes severe eye irritation; may cause digestive tract irritation; moisture sensitive.	E	3	NR	N/P-D
Clayton yellow ---- powder (*thiazole yellow G*) $C_{28}H_{19}N_5Na_2O_6S_{4(s)}$	B	0	1	1	No adverse effects; flammable if heated or ignited, air-dust mixture explosive; light sensitive.	NC	8	NR	T
cobalt ----- powder or solid $Co_{(s)}$	C	2	0	0	Powder may cause irritation to eyes, skin and respiratory tract; harmful if swallowed; powder will oxidize in air; possible human carcinogen.	D2	8	4.1	R or WF/I
cobalt(II) acetate – crystals $Co(C_2H_3O_2)_2 \cdot 4H_2O_{(s)}$	A	1	0	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled; chronic exposure may affect the thyroid, lungs, heart and kidneys.	NC	8	NR	WF/I or N/P-T
cobalt(II) carbonate----------powder $CoCO_{3(S)}$	B	2	0	0	Causes irritation to eyes, skin and respiratory tract; harmful if swallowed or inhaled; chronic exposure may effect the thyroid, lungs, heart and kidneys.	D1, D2	8	6.1	WF/I or N/P-T

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
cobalt(II) chloride, anhydrous and hexahydrate ------- powder $CoCl_2$ & $CoCl_2 \bullet 6H_2O_{(s)}$	B	2	0	0	May cause irritation of skin, eyes and mucous membranes; may be harmful if inhaled or absorbed through skin; toxic by ingestion; possible carcinogen.	D1, D2	8	6.1	WF/I or N/P-T
cobalt(II) nitrate hexahydrate ------- crystals $Co(NO_3)2 \bullet 6H_2O_{(s)}$	B	2	0	0	Causes irritation of skin, eyes and mucous membranes; harmful if inhaled or absorbed through skin.	C, D2	8	6.1	WF/I
cobalt(II) sulfate heptahydrate ------ crystals $CoSO4 \bullet 7H_2O_{(s)}$	B	2	0	0	Causes irritation of skin, eyes and mucous membranes; may be harmful if inhaled or absorbed through skin.	D1, D2	8	6.1	WF/I or N/P-T
colchicine ---------- powder $C_{22}H_{25}NO_{6(s)}$	C	4	1	0	Corrosive and highly toxic if swallowed; causes severe irritation of eyes; causes irritation of skin and respiratory tract; may be fatal if inhaled or absorbed through skin; may cause birth defects; affects the reproductive system; combustible if heated or ignited.	D1, D2	8	6.1	WF/I
collodion solution --- liquid (*pyroxylin solution*) mixture: ethyl ether --------- 60-70% ethyl alcohol ------- 22-26% nitrocellulose -- --- ~5.2 %	C	2	4	0	Causes skin irritation and possible burns, moderate eye irritation; harmful if inhaled, swallowed or absorbed through skin; extended exposure to vapour can cause lung damage; may cause central nervous system depression or reproductive and fetal effects; may cause liver and kidney damage; prolonged exposure to air may form unstable explosive peroxides; extremely flammable; possible human carcinogen.	B, D2	5	3	WF/I

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congo red ---------- solution mixture: water ---------- 99.0% congo red ---------- 0.1% $C_{32}H_{22}N_6Na_2O_6S_{2(aq)}$	B	1	0	0	May cause irritation to skin and eyes; excessive absorption through skin or by ingestion may be harmful.	D1, D2	8	9	WF/I
congo red ---------- powder $C_{32}H_{22}N_6Na_2O_6S_{2(s)}$	C	3	1	0	Toxic; may be fatal by ingestion, inhalation or by skin absorption; causes irritation of eyes and possibly skin; possible human carcinogen; combustible if heated or ignited, dust-air mixture explosive.	D1, D2	8	6.1	WF/I
copper metal ------ powder $Cu_{(s)}$	B	2	0	0	Causes irritation to skin, eyes and mucous membranes; harmful if swallowed or inhaled; affects the liver and kidneys; chronic exposure may cause tissue damage.	NC	8	NR	R
copper metal – strip or wire $Cu_{(s)}$	A	0	0	0	No adverse effects.	NC	8	NR	R
copper(II) acetate monohydrate ------- powder $Cu(CH_3COO)_2 \bullet H_2O_{(s)}$	B	2	0	0	Causes irritation to skin and respiratory tract, causes eye burns; harmful if swallowed.	NC	8	9	WF/I or N/P-T
copper(II) bromide ----------crystals $CuBr_{2(s)}$	B	2	0	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed; affects central nervous system, liver and kidneys.	NC	8	NR	WF/I or N/P-T
copper(II) carbonate basic---------- powder $(CuCO_3 \bullet CU(OH)_{2(s)}$	B	2	0	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed; affects the liver and kidneys.	D1, D2	8	NR	WF/I or N/P-T

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copper(I) & (II) chloride (anhydrous) -------- crystals CuCl & $CuCl_{2(s)}$	B	2	0	0	Causes irritation to skin, eyes, respiratory and digestive tract; harmful if inhaled or swallowed; may cause lung, liver and kidney damage.	D1, D2, E	8	8	WF/I or N/P-T
copper(II) nitrate hemihydrate ------- crystals $Cu(NO_3)_2 \bullet 2.5H_2O_{(s)}$	B	2	0	0 OX	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed; affects the liver and kidneys; strong oxidizer, contact with other material may cause fire.	C, D2, E	6	5.1	WF/I
copper(II) oxide -- powder $CuO_{(s)}$	B	2	0	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed; affects the liver and kidneys.	D2	8	NR	T
copper(II) sulfate anhydrous & pentahydrate-------- powder $CuSO_4$ & $CuSO4 \bullet 5H_2O_{(s)}$	B	2	0	0	May cause irritation to skin, eyes and respiratory tract; harmful if swallowed; affects the liver and kidneys.	D1, D2	8	9	WF/I or N/P-T
copper(II) sulfide- powder $CuS_{(s)}$	B	2	0	0	Causes irritation to skin, eyes and respiratory tract; harmful if swallowed; affects the liver and kidneys.	NC	8	NR	WF/I or N/P-T
cream of tartar ---- powder (*potassium hydrogen tartrate*) $KHC_4H_4O_{6(s)}$	A	0	0	0	No adverse effects.	NC	8	NR	T or D (aq)
cresol ---------- liquid (*cresylic acid*) $C_7H_8O_{(l)}$	B	2	2	1	May cause severe skin and eye irritation; harmful by inhalation, ingestion, or absorption through skin; chronic exposure may cause damage to kidneys, liver, lungs, blood, or central nervous system; flammable.	B, D1	5	6.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
cryolite ---------- chunk (*sodium aluminum fluoride*) $Na_3AlF_{6(s)}$	C	3	0	0	Toxic; extremely destructive of mucous membranes and upper respiratory tract; harmful by inhalation; ingestion or through skin absorption; prolonged exposure through inhalation or ingestion can cause serious damage to health.	D1, D2	8	8	WF/I
crystal violet ------- powder (*gentian violet*) $C_{25}H_{30}N_3Cl_{(s)}$	B	2	1	0	Causes irritation to skin, eyes and mucous membranes, may cause eye injury; harmful if swallowed; possible human carcinogen; dust-air mixture explosive.	D1, D2	8	6.1	T
crystal violet stain ---------- solution mixture: ethanol ---------- <12.0% methyl alcohol ------ <1.0% phenol ---------- <1.0% crystal violet ------- < 0.4% water ---------- balance	B	2	1	0	May cause irritation of skin, eyes, respiratory and digestive tract; inhalation of high concentrations cause central nervous effects, may cause liver and kidney damage and reproductive and fetal effects; possible human carcinogen.	D2	8	3 (6.1)	WF/I
cyclohexane ---------- liquid (*hexamethylene*) $C_6H_{12(l)}$	B	2	3	0	Respiratory, eye, and skin irritant; harmful by inhalation, ingestion or skin absorption; highly flammable.	B	5	3	WF/I
cyclohexanol --------- liquid (hexalin,*cyclohexyl alcohol*) $C_6H_{12}O_{(l)}$	B	2	2	0	Severe skin and eye irritant; harmful by inhalation, ingestion or skin absorption; flammable; reacts violently with oxidizing agents.	B, D1	5	3	WF/I
cyclohexene ---------- liquid (*tetrahydrobenzene)* $C_6H_{10(l)}$	B	1	3	0	Skin, respiratory tract, and eye irritant; highly flammable; strong offensive odour.	B, D2	5	3	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
cysteine ---------- crystals $C_3H_7NO_2S_{(s)}$ or $HSCH_2CH(NH_2)COOH_{(s)}$	A	1	0	0	May be harmful if swallowed.	NC	8	NR	T
cystine ---------- crystals (*L-cystine*) $C_6H_{12}N_2O_4S_{2(s)}$	A	0	0	0	No adverse effects.	NC	8	NR	T
dextrose ---------- crystals (*glucose*) $C_6H_{12}O_{6(s)}$	A	0	0	0	No adverse effects.	NC	8	NR	T
diastase ---------- powder (*amylolytic enzymes*) formula not applicable	A	0	1	0	Mechanical irritant, no adverse health effects; combustible if heated or ignited, dust-air mixture explosive.	NC	8	NR	T
1,4 – dibromo-benzene ---------- crystals (*p - dibromobenzene*) $C_6H_4Br_{2(s)}$	B	1	0	0	Causes irritation to skin, eyes, and respiratory tract.	NC	8	NR	WF/I
dibutyl phthalate ---- liquid (*n-butyl phthalate*) $C_6H_4(CO_2C_4H_9)_{2(l)}$	B	2	1	0	Causes skin and respiratory tract irritation and severe eye irritation; harmful if swallowed or inhaled; combustible if heated or ignited	D2	8	9	WF/I
p-dichloro-benzene ---------- crystals (*l,4-dichlorobenzene*) $C_6H_4Cl_{2(s)}$	C	2	2	0	Causes irritation to skin, eyes, and respiratory tract; harmful if inhaled, swallowed, or absorbed through the skin; affects the respiratory system, liver, kidneys, and blood; flammable, forms explosive vapour-air mixture; possible human carcinogen.	D1, D2	4	9	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
1,2-dichloroethane-- liquid $ClCH_2CH_2Cl_{(l)}$	C	2	3	0	Harmful if swallowed, inhaled or absorbed through skin, affects the central nervous system, liver, kidneys, and cardiovascular system, flammable liquid and vapour; possible human carcinogen.	B, D1, D2	5	3 (6.1)	WF/I
dichloromethane ---- liquid *methylene chloride*) $CH_2Cl_{2(l)}$	C	2	1	0	May cause irritation and possible burns to skin, eyes, and respiratory tract; readily absorbed through skin; may depress central nervous system function; combustible if heated or ignited, vapours may form explosive mixture with air; mutagen and possible human carcinogen.	D1, D2	5	6.1	WF/I
2,4-dichlorophenoxy-acetic acid -------- powder (*2,4 D*) $C_8H_6Cl_2O_{3(s)}$	C	3	0	1	Toxic if swallowed or inhaled; eye, skin, and respiratory irritant; may be harmful by skin contact; may cause central nervous system damage; possible human carcinogen; decomposes in water.	D1, D2	8	6.1	WF/I
1,2-dichlorotetrafluoro-ethane ---------- gas (*freon 114*) $CClF_2CClF_{2(g)}$ or $C_2Cl_2F_{4(g)}$	B	1	0	0	May irritate skin, eyes, and respiratory tract. Contributes to ozone depletion in the atmosphere.	NC	8	NR	WF/I
diethyl ether ---------- liquid (e*thyl ether*) $C_4H_{10}O_{(l)}$ or $C_2H_5OC_2H_{5(l)}$	C	2	4	1	Causes skin, eye, and respiratory irritation; harmful by ingestion, inhalation, or skin absorption; may cause inebriation or coma; extremely flammable;	B, D1	5	3	WF/I
dimethylglyoxime-- powder *(diacetlyldioxime)* $C_4H_8N_2O_{2(s)}$	A	1	1	0	May irritate skin, eyes, and respiratory tract; harmful if swallowed; flammable if heated.	NC	8	NR	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
dimethyl sulfate ------ liquid $(CH_3)_2SO_{4(l)}$	C	4	2	0	Toxic and corrosive; causes severe burns to any area of contact; vapours extremely toxic, a few whiffs can be fatal; vapours have no odour or immediate irritation to warn of inhalation exposure; may also be fatal if swallowed or absorbed through skin; delayed effects are severe inflammation, chest tightness, trouble breathing, and severe pulmonary damage; flammable liquid and vapours; possible human carcinogen.	B, D1, D2	5	6.1 (8)	WF/I
2, 4–dinitrophenol- powder (*aldefin*) $C_6H_4N_2O_{5(s)}$	C	3	2	0	Toxic by inhalation and ingestion, danger of cumulative effects; flammable, may explode when heated.	B, D1, D2	4	4.1	WF/I
1,4-dioxane ---------- liquid (*1,4-diethylene dioxide*) $C_4H_8O_{2(l)}$	C	3	3	1	Most toxic by inhalation, easily absorbed through lungs, poisoning has poor warning properties; anhydrous form oxidizes slowly forming explosive peroxides in storage; highly flammable; a possible human carcinogen.	B, D1, D2	5	3	WF/I
diphenylamine ---- crystals (*n-phenylbenzeneamine*) $C_{12}H_{10}NH_{(s)}$	C	3	1	0	Toxic, inhalation causes systemic poisoning; causes irritation to skin, eyes, and respiratory tract; harmful if swallowed, inhaled, or absorbed through skin; affects the blood; prolonged exposure damages the nervous system, liver, kidneys, and bone marrow; flammable if heated; possible mutagen.	NC	8	6.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
dry ice ---------- solid/gas (*carbon dioxide*) $CO_{2(s)}$ & $CO_{2(g)}$	C	2	0	0	Cryogenic solid; causes frostbite or extensive freezing of flesh on contact; gas will elevate rate of breathing and heart rate; gas non-toxic but displaces oxygenated air and can cause rapid suffocation with high concentrations.	NC	8	9	A
EDTA ---------- powder (*ethylenedinitrilotetraacetic acid*, *edetic acid*) $C_{10}H_{16}N_2O_{8(s)}$ or the dihydrate $C_{10}H_{12}N_2Na_4O_8 \cdot 2H_2O_{(s)}$	A	2	0	0	Causes eye irritation, may cause irritation to skin and respiratory tract; may be harmful if swallowed or inhaled.	NC	8	NR	WF/I
eosin B ---------- powder $C_{20}H_6Br_2N_2Na_2O_{9(s)}$	A	2	1	0	May cause irritation to skin, eyes, or respiratory tract; may be harmful if swallowed, inhaled or absorbed through skin; combustible if heated or ignited.	NC	8	NR	WF/I
eosin Y ---------- solution mixture: water ---------- 99.8% eosin Y ---------- 0.2% $C_{20}H_6Br_4Na_2O_{5(aq)}$	A	1	0	0	May cause irritation of the eyes and skin; excessive absorption through skin or by ingestion may be harmful.	NC	8	NR	D
eosin Y ---------- powder $C_{20}H_6Br_4Na_2O_{5(s)}$	A	2	0	0	May cause irritation of the eyes, skin, respiratory and digestive tracts; harmful if inhaled or absorbed through skin, may be harmful if ingested.	NC	8	NR	WF/I
epinephrine 99% - powder (*adrenalin*) $C_9H_{13}NO_{3(s)}$	B	2	1	0	May cause skin and eye irritation; harmful if swallowed, inhaled or absorbed through skin; increases heart rate, blood pressure; may cause central nervous system depression; powder-air mixture explosive.	D2	8	6.1	WF/I

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epsom salts ------ powder (*magnesium sulfate heptahydrate*) $MgSO_4 \cdot 7H_2O_{(s)}$	A	1	0	0	Dust may be slightly irritating to respiratory system, may be harmful if swallowed.	NC	8	NR	T
eriochrome black T-- liquid mixture: water ---------- 0.8% methyl alcohol ------ 98.4% ammonium hydroxide ---------- 0.3% eriochrome black T - 0.4%	B	2	3	0	Causes irritation of skin, eyes and respiratory tracts; harmful if inhaled, swallowed, or absorbed through skin; highly flammable liquid and vapour.	B, D1, D2	5	3 (6.1)	D
eriochrome blackT-powder $C_{20}H_{12}N_3NaO_7S_{(s)}$	A	1	0	0	Causes eye irritation; may cause irritation of the skin, digestive and respiratory tracts.	NC	8	NR	T
ethanoic acid, glacial ---------- liquid (*glacial acetic acid*) $CH_3COOH_{(l)}$	B	3	2	0	Corrosive; liquid and mist cause severe burns to all body tissue; may be fatal if ingested; harmful if inhaled; flammable liquid and vapour.	B, E	5, 1	8 (3)	WF/I or N/P-D
ethanoic acid--------solution (*acetic acid,vinegar*) mixture: CH_3COOH --------- 7% H_2O ---------- 93% $CH_3COOH_{(aq)}$	A	1	0	0	Causes irritation of the nose, throat, and respiratory tract, prolonged contact may cause burns and dermatitis.	NC	1	NR	N/P-D
ethyl acetate ---------- liquid $CH_3COOC_2H_{5(l)}$ or $C_4H_8O_{2(l)}$	B	2	3	0	Causes irritation to skin, eyes, and respiratory tract; harmful if swallowed or inhaled; affects the central nervous system; highly flammable liquid.	B, D2	5	3	WF/I

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ethyl alcohol ---------- liquid *(ethanol)* $C_2H_5OH_{(l)}$	B	0	3	0	Causes moderate skin and severe eye irritation; inhalation or ingestion of high concentrations may depress the central nervous system; highly flammable.	B, D1, D2	5	3	D
ethylamine ---- liquid & gas (mo*noethyamine)* $C_2H_7N_{(l)}$ & $C_2H_7N_{(g)}$	C	3	4	0	Corrosive; higher concentrations destructive to skin, airway, and eyes; inhalation may be fatal; vapours extremely flammable.	B, D1	5	3	WF/I or RS (gas in cylinder)
ethyl bromide --------- liquid (b*romoethane*) $C_2H_5Br_{(l)}$ or $CH_3CH_2Br_{(l)}$	C	2	3	0	Irritating to skin and eyes; very irritating upon inhalation; narcotic, may cause liver and kidney damage; harmful if swallowed; highly flammable, forms explosive mixture with air; possible carcinogen, mutagen.	B, D1, D2	5	6.1	WF/I
ethyl butyrate --------- liquid $C_6H_{12}O_{2(l)}$	B	1	3	0	Vapours may cause skin, eye, mucous membrane and upper respiratory tract irritation; may be absorbed through skin; highly flammable liquid.	B	5	3	WF/I
ethylene dichloride -- liquid (*1,2 – dicholoroethane)* $ClCH_2CH_2Cl_{(l)}$	C	2	3	0	Harmful if swallowed, inhaled, or absorbed through skin; causes irritation to skin, eyes, and respiratory tract; inhalation of concentrated amounts affects the central nervous system, liver, kidneys, and cardiovascular system; highly flammable liquid and vapour; possible human carcinogen.	B, D1, D2	5	3 (6.1)	WF/I
ethylenediamine ----- liquid (*1,2-ethanediamine)* $C_2H_8N_{2(l)}$	C	3	2	0	Corrosive; causes burns to any area of contact, very destructive of mucous membranes; harmful if inhaled, swallowed or absorbed through skin; flammable liquid and vapours; mutagen, negative reproductive effects.	D2	5	8 (3)	WF/I

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ethylenedinitrilotetraacetic acid (EDTA) -------- powder *(edetic acid)* $C_{10}H_{16}N_2O_{8(s)}$ or $C_{10}H_{12}N_2Na_4O_8 \cdot 2H_2O_{(s)}$	A	2	0	0	Causes eye irritation, may cause irritation to skin and respiratory tract; may be harmful if swallowed or inhaled.	NC	8	NR	WF/I
ethylene glycol ------- liquid (*1,2-ethanediol*) $C_2H_6O_{2(l)}$	B	2	1	0	Irritating to skin, eyes, and respiratory system, harmful if swallowed, can be lethal to some people; possible risk to fertility and fetal development; combustible at higher temperatures.	D2	8	3	WF/I
ethyl ether ---------- liquid *(diethyl ether)* $C_4H_{10}O_{(l)}$	C	2	4	1	Causes skin, eye, and respiratory irritation; harmful by ingestion, inhalation, or skin absorption; may cause inebriation or coma; extremely flammable.	B, D1	5	3	WF/I
ethyl iodide ---------- liquid (*iodoethane*) $C_2H_5I_{(l)}$	B	2	1	1	Causes irritation to skin, eyes, and respiratory tract; harmful if swallowed or inhaled; can affect the nervous system and motor control with repeated exposure; reacts with water forming toxic fumes; decomposes in light and air releasing free iodine; combustible if heated.	D2	8	6.1	WF/I
Fehling's reagent A ---------- solution mixture: copper(II) sulfate -- 4.43% water ---------- 95.57% $CuSO_{4(aq)}$	B	2	0	0	Splashes may cause irritation to skin or eyes, misting or vapours from heating may cause irritation of the respiratory tract; may be harmful if swallowed.	D1, D2, E	8	9	WF/I or N/P-D

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Fehling's reagent B ---------- solution mixture: sodium potassium tartrate---------- 24% potassium hydroxide– 7% water ---------- 69%	B	2	0	0	Splashes cause eye and skin burns, may cause severe respiratory or digestive tract irritation and burns if inhaled or ingested.	D2, E	8	8	D
feldspar ---------- chunks (k*aolinite*) $H_4Al_2Si_2O_9 \bullet SiO_{2(s)}$	A	1	0	0	Dust may irritate skin, eyes, respiratory and digestive tracts; repeated prolonged inhalation can lead to silicosis.	NC	8	NR	T
florisil ---------- solid (m*agnesia-silica gel*) MgO3.75 $SIO_2 \bullet XH_2O_{(s)}$	A	1	0	0	May cause irritation of the skin, eyes, and respiratory tract.	NC	8	NR	T
fluorine ---------- gas $F_{2(g)}$	C	4	0	4 OX ~~W~~	Extremely corrosive and toxic gas; direct exposure of skin and eyes produces burns in seconds, severely irritates nose and throat; most powerful oxidizing agent, reacts explosively with a wide range of organic and inorganic substances; water reactive.	D1, C, F	6, 7	2.3	RS
fluorite ---------- crystals (c*alcium fluoride*) $CaF_{2(s)}$	A	2	0	0	May cause irritation to skin, eyes, and respiratory tract; may be harmful if swallowed or inhaled.	NC	8	NR	T
formaldehyde ----- solution (f*ormalin, methanal*) mixture: HCHO ---------- 37% CH_3OH ----------12-15% H_2O ---------- 48-53%	C	3	2	0	Toxic by inhalation, ingestion, and through skin absorption; extremely destructive to tissues of the mucous membranes and upper respiratory tract; ingestion may be fatal or cause blindness; flammable liquid and vapour; mutagen; probable human carcinogen.	B, D1, D2	5	3 (8)	WF/I

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formalin ---------- solution mixture: HCHO ---------- 3 –4% CH_3OH ----------1-1.5% H_2O ---------- 94-96%	C	2	2	0	Harmful by inhalation and through skin absorption, may be fatal if ingested; causes irritation to skin, eyes, and respiratory tract; ingestion may be fatal or cause blindness; mutagen; flammable vapour; probable human carcinogen.	B, D1, D2	5	9	WF/I
formic acid -------- solution (*methanoic acid*) mixture: formic acid --------- 85-98% water ---------- 02-15% $HCOOH_{(aq)}$	B	3	2	0	Corrosive; causes severe burns to skin, eyes, mucous membranes and respiratory tract; may be fatal by ingestion, inhalation, or skin absorption; flammable liquid; decomposes to produce carbon monoxide during prolonged storage thus potential explosive hazard.	B, E	1, 5	8	WF/I or N/P-D
d-fructose --------- powder $C_6H_{12}O_{6(s)}$	A	1	1	0	Powder may cause mild irritation of the eyes and respiratory tract; flammable if heated.	NC	8	NR	T
fuchsin (acid) —-----powder (*acid violet 19*) $C_{20}H_{17}N_3Na_2O_9S_{3(s)}$	B	2	1	0	May cause irritation of skin, eyes, and respiratory tract; may be harmful if swallowed, inhaled, or absorbed through skin; combustible if heated.	D2	3	NR	T
fumaric acid ------- powder (*2-butenedioic acid*) $C_4H_4O_{4(s)}$	B	2	1	0	May cause skin, respiratory, and digestive tract irritation; causes eye irritation; may cause kidney damage, flammable if heated.	D2	3	NR	WF/I or N/P-D
galactose ---------- powder $C_6H_{12}O_{6(s)}$	A	0	1	0	No adverse affects; combustible if heated or ignited, dust-air mixture explosive.	NC	8	NR	T
galena ---------- solid (*lead(II) sulphide*) $PbS_{(s)}$	A	2	0	0	Dust may irritate the skin and eyes; harmful if swallowed or inhaled.	D1	8	6.1	T

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gallium —- solid or powder $Ga_{(s)}$	A	2	0	0	Causes skin, eye, and respiratory tract irritation; may cause gastro-intestinal tract irritation with nausea, vomiting, and diarrhea; may cause bone marrow abnormalities with damage to blood forming tissues.	D2	8	8	T
gentian violet ----- solution mixture: methyl alcohol ------ 20.0% water ---------- 78.5% ammonium oxalate- 1.0% gentian violet ------ 0.5%	B	2	1	0	May cause irritation to skin, eyes, respiratory and digestive tracts; harmful and possibly fatal if swallowed or inhaled in excess; flammable vapours.	D1, D2	8	NR	D
gentian violet ------ powder (*crystal violet)* $C_{25}H_{30}N_3Cl_{(s)}$	B	2	1	0	May cause skin and respiratory irritation; causes severe eye irritation; harmful if swallowed; may be harmful if inhaled; combustible if heated or ignited, air–powder mixture explosive; may be a human carcinogen.	D1, D2	8	6.1	T
germanium–powder/solid $Ge_{(s)}$	B– solid C-powder	2	2	0	Causes skin, eye, mucous membrane, and respiratory tract irritation; may be harmful if absorbed through skin, inhaled or ingested; may cause damage to liver and kidneys; flammable solid, dust-air mixture explosive.	B, D2	8	6.1	T- solid WF/I-powder
gibberellic acid --- powder $C_{19}H_{22}O_{6(s)}$	A	1	1	0	May cause skin, eye, respiratory and digestive tract irritation; flammable if heated.	NC	3	NR	D
glucose ---------- powder (d*extrose*) $C_6H_{12}O_{6(s)}$	A	0	1	0	No adverse affects. Flammable if heated.	NC	8	NR	T

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glutamic acid ----- crystals $C_5H_9NO_{4(s)}$	A	1	1	0	May cause skin, eye, respiratory and digestive tract irritation; combustible if heated or ignited, dust-air mixture explosive.	NC	3	NR	WF/I or N/P-T
glycerin ----- viscous liquid *(glycerol, 1,2,3-propanetriol)* $C_3H_8O_{3(l)}$	A	1	1	0	May cause skin and eye irritation; ingestion of large amounts may cause irritation of the intestinal tract; inhalation of mist may irritate the respiratory tract; contact with strong oxidants (chromium trioxide, potassium chlorate, potassium permanganate) may be explosive; flammable if heated.	NC	8	NR	D
glycine ---------- crystals $C_2H_5NO_{2(s)}$	A	1	0	0	May cause skin, eye, respiratory, and digestive tract irritation, the latter with ingestion of large amounts.	NC	8	NR	T
D-glycogen -------- powder (*animal starch*) $(C_6H_{10}O_5)_{n(s)}$	A	0	1	0	No adverse health effects; flammable if heated or ignited, air-dust mixture explosive.	NC	8	NR	T
gold ---- powder or pieces $Au_{(s)}$	A	1	0	0	Powder may cause, eye, respiratory, and digestive tract irritation.	NC	8	NR	R
graphite ---------- solid (*carbon*) $C_{(s)}$	B-powder	1	1	0	Dust may cause skin, eye, and respiratory tract irritation; may be harmful if inhaled; cancer hazard with long-term exposure if quartz present; flammable solid.	NC	8	4.2	T
halite ---------- crystalline (*sodium chloride*) $NaCl_{(s)}$	A	1	0	0	Dust may cause irritation to eyes, skin and respiratory tract.	NC	8	NR	T
hematite ---------- chunks (*iron(III) oxide*) $Fe_2O_{3(s)}$	A	0	0	0	No adverse effects	NC	8	NR	T

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n -heptane ---------- liquid $C_7H_{16(l)}$	B	1	3	0	Causes skin and eye irritation; ingestion causes irritation with nausea, vomiting and diarrhea; inhalation causes respiratory tract irritation with dizziness headache, and unconsciousness; flammable liquid.	B	5	3	WF/I
n-hexane ---------- liquid $C_6H_{14(l)}$	B	2	3	0	Harmful by skin absorption, inhalation or ingestion; vapours irritating to mucous membranes and respiratory tract; may cause liver and kidney damage; flammable	B, D2	5	3	WF/I
1,6-hexanediamine -- solid (h*examethylenediamine*) $C_6H_{16}N_{2(s)}$	C	3	2	0	Corrosive; may cause severe irritation and possible burns to skin, eyes, respiratory, and digestive tracts; may be harmful if swallowed, inhaled, or absorbed through skin; may cause liver damage; may cause fetal effects; flammable solid	E	4	8	WF/I
l-(+) histidine ----- crystals $C_6H_9N_3O_{2(s)}$	A	1	0	0	May cause irritation to skin, eyes, digestive and respiratory tracts.	NC	8	NR	T
hydrochloric acid– solution (m*uriatic acid*) mixture: HCl ---------- 36.5% H_2O ---------- 63.5% $HCl_{(aq)}$	A- 5% or less B- more than 5%	3	0	0	Corrosive; causes eye and skin burns; harmful if vapours inhaled or liquid swallowed, may cause severe respiratory or digestive tract irritation with possible burns; may cause fetal effects	D1, E	1	8	WF/I or N/P-D
hydrofluoric acid-- solution mixture: HF ---------- 48-52% H_2O ---------- 48-52% $HF_{(aq)}$	C	4	0	1	Extremely corrosive and toxic; vapour causes severe burns to skin, eyes and respiratory tract, burns to skin may not be immediately painful or visible; may be fatal if swallowed or inhaled; causes bone damage; reaction with metals generates explosive hydrogen gas.	D1, D2, E	1	8 (6.1)	WF/I or N/P-D

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hydrogen ---------- gas $H_{2(g)}$	B	0	4	0	No adverse effects; highly flammable gas.	A, B	8	2.1	A
hydrogen cyanide -- liquid or gas (*hydrocyanic* or *prussic acid if aq*) $HCN_{(l)}$ or $HCN_{(g)}$	C	4	4	2	Very toxic; severe irritation of eyes and respiratory tract; very toxic by inhalation, skin contact, or ingestion, potentially fatal if inhaled or swallowed; highly flammable, vapours may cause flash fire; avoid contact or mixing with oxidizers, alkalis, amines, sulfuric acid, acetaldehyde, hydrogen chloride + alcohol.	B, D1, D2, E	5, 1	6.1	WF/I
hydrogen peroxide ---------- solution mixture: hydrogen peroxide -- 30% water ---------- 70% $H_2O_{2\ (aq)}$	B	3	0	1 OX	Corrosive; causes burns to skin, eyes and respiratory tract; harmful if swallowed or inhaled; strong oxidizer, contact with oxidizable material may cause violent combustion; decomposes into water and oxygen, can decompose violently upon heating.	C, E, F	6	5.1 (8)	D
hydrogen peroxide ---------- solution mixture: hydrogen peroxide–2 - 4% water ---------- 96-98% $H_2O_{2\ (aq)}$	A	1	0	1 OX	Causes eye irritation, may be harmful if swallowed; oxidizer; decomposes into water and oxygen.	C	6	NR	D
hydrogen sulfide —---- gas $H_2S_{(g)}$	C	4	0	0	Very corrosive and toxic; low concentrations (50 ppm) cause eye, and respiratory membrane irritation; death occurs in 1-4 hours at 300-500 ppm, immediate respiratory arrest in excess of 1000 ppm; toxic by ingestion or inhalation; severe exposures, short of death, may cause long-term symptoms including lung damage, memory loss, paralysis of facial muscles, or nerve tissue damage.	A, D1, D2, E	8	2.3 (2.1)	RS

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
hydroquinone ---- crystals (*1,4-benzenediol*) $C_6H_6O_{2(s)}$	B	2	1	0	Causes irritation to skin, respiratory tract, and eyes; repeated exposure to dust may cause eye injury; harmful if inhaled or swallowed; combustible if heated or ignited, powder-air mixture explosive.	D1, D2	8	6.1	WF/I
indigo carmine ----- powder $C_{16}H_8N_2Na_2O_8S_{2(s)}$	A	2	0	0	May cause skin or eye irritation; may be harmful if swallowed, inhaled or absorbed through skin.	NC	8	NR	T
indium ---------- solid $In_{(s)}$	A	1	1	0	Solid has low toxicity; high concentrations of dust may irritate eyes, mucous membranes, skin, and upper respiratory tract; flammable dust-air mixture.	NC	6	NR	T
3-indoleacetic acid --- solid (h*eteroauxin, IAA*) $C_{10}H_9NO_{2(s)}$	A	0	0	0	No adverse effects to skin, eyes, respiratory or digestive tracts; may cause fetal effects with chronic exposure based on animal studies.	NC	8	NR	WF/I or N/P-D
indophenol sodium salt --------- crystals $C_{12}H_8NaNO_{(s)}$	B	1	1	0	Causes irritation to skin, eyes, and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; flammable if heated or ignited.	D1	8	NR	WF/I
inositol ---------- crystals (h*exahydrox-ycyclohexane*) $C_6H_6(OH)_{6(s)}$	B	1	1	0	May cause skin, eye or respiratory tract irritation; flammable if ignited or heated, dust-air mixture explosive.	NC	8	NR	T

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iodine ---------- crystals $I_{2(s)}$	B	3	0	1 ox	Corrosive; crystals and vapours cause severe irritation or burns to skin, eyes, respiratory tract and any area of contact; may be fatal if swallowed or inhaled; affects cardiovascular and central nervous systems; strong oxidizer, contact with oxidizable material may cause fire.	C, D1, D2, E	6 (7)	6.1 (8)	WF/I or N/P-D
iodoethane ---------- liquid (*ethyl iodide*) $C_2H_5I_{(l)}$	B	2	1	1 W	Causes irritation to skin, eyes, and respiratory tract; harmful if swallowed or inhaled; narcotic, can affect the nervous system and motor control with repeated exposure; reacts with water forming toxic fumes; decomposes in light and air releasing free iodine; combustible if heated.	D2	8	6.1	WF/I
iron ---------- powder $Fe_{(s)}$	A	1	1	1	A skin, eye, and, mucous membrane irritant ; combustible if exposed to flame.	NC	8	4.1	T
iron ---------- filings $Fe_{(s)}$	A	0	0	0	No adverse effects.	NC	8	NR	R or T
iron(III) ammonium citrate ---------- powder $xFe{\bullet}xNH_3{\bullet}C_6H_8O_{7(s)}$	A	0	1	0	May cause irritation to skin, eyes, and respiratory tract; may be harmful if swallowed; combustible if heated.	NC	8	9.2	WF/I
iron(II) ammonium sulfate hexahydrate ------- crystals (m*ohr's salt)* $Fe(NH_4)_2(SO_4)_2{\bullet}6H_2O_{(s)}$	A	2	0	0	Causes irritation to skin, eyes, and respiratory tract; harmful if swallowed or inhaled; may cause liver damage and cardiac disturbances; decomposes if heated.	NC	8	9	WF/I or N/P-D

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iron(III) ammonium sulfate ---------- crystals $FeNH_4SO_{4(s)}$	A	1	0	0	May cause irritation of the skin, eyes, respiratory and digestive tracts; may cause cardiac disturbances, and liver and kidney damage.	NC	5	NR	WF/I or N/P-D
iron(II) chloride hydrate ---------- crystals $FeCl_2 \bullet xH_2O_{(s)}$	B	3	0	1	Corrosive; causes severe irritation to skin, eyes, mucous membranes, and respiratory tract; harmful by skin absorption, inhalation or ingestion; may cause liver, kidney, pancreas damage and cardiovascular collapse; reacts violently with oxidizing agents; unstable	E	8	8	WF/I or N/P-D
Iron(III) chloride hexahydrate ------- crystals $FeCl_3 \bullet 6H_2O_{(s)}$	B-crystals C-powder anhydrous	3	0	0	Corrosive; extremely destructive to tissues of skin, eyes, mucous membranes and upper respiratory, tract; swallowing can cause severe burns to mouth, throat, and stomach; affects the liver.	D1, E, F	8	5.1	WF/I or N/P-D
iron(III) nitrate nonahydrate ------- crystals $Fe(NO_3)_3 \bullet 9H_2O_{(s)}$	A	2	0	0 OX	Causes severe irritation of the skin, eyes, and respiratory tract; harmful if inhaled or ingested; affects the liver; strong oxidizer, contact with flammable material may cause fire.	C	6	5.1	WF/I
Iron(III) oxide ------ powder $Fe_2O_{3(s)}$	A	2	0	0	May cause irritation to skin, eyes, and respiratory tract, harmful if inhaled.	NC	8	NR	WF/I or N/P-D
iron(III) sulfate, hydrated ---------- powder $Fe_2(SO_4)_3 \bullet xH_2O_{(s)}$	A	2	0	0	Causes irritation to skin, eyes, and respiratory tract; harmful if swallowed or inhaled; affects the liver.	NC	8	NR	T or D
iron(II) sulfate ----- crystals heptahydrate (*ferrous sulfate 7 - hydrate*) $FeSO_4 \bullet 7H_2O_{(s)}$	A	1	0	0	Causes irritation with excessive inhalation or prolonged exposure to skin, exposure to eyes causes irritation that could be damaging; low toxicity, used as a food and feed iron supplement.	D2	8	NR	T

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iron(II) sulfate heptahydrate ------- powder $FeSO_4 \bullet 7H_2O_{(s)}$	A	2	0	0	Causes severe irritation to eyes; may cause irritation to skin, mucous membranes, and respiratory tract; moderately toxic by ingestion; may affect the liver, kidneys, cardiovascular and central nervous systems.	D2	8	NR	T or D (aq)
iron(II) sulfide ----- powder $FeS_{(s)}$	A	2	1	0	Dust causes irritation of skin, eyes and mucous membranes; prolonged inhalation may lead to pulmonary fibrosis, damage to kidneys and liver dried form flammable, will spontaneously ignite if exposed to air.	NC	8	4.1	WF/I
iso-amyl alcohol ------ liquid *(isopentyl alcohol)* $C_4H_{10}O_{(l)}$ or $(CH_3)_2CHCH_2CH_2OH_{(l)}$	B	2	2	0	Causes irritation to skin, mucous membranes, and respiratory tract, severe irritant to eyes; harmful if swallowed, inhaled, or ingested; hematotoxic; affects the central nervous system; flammable liquid and vapour, emits toxic fumes when burned.	B, D2	5	3	WF/I
iso-pentyl alcohol -- liquid (*iso-amyl alcohol*) $C_4H_{10}O_{(l)}$ or $(CH_3)_2CHCH_2CH_2OH_{(l)}$	B	2	2	0	Causes irritation to skin, mucous membranes, and respiratory tract, severe irritant to eyes; harmful if swallowed, inhaled, or ingested; hematotoxic; affects the central nervous system; flammable liquid and vapour, emits toxic fumes when burned.	B, D2	5	3	WF/I
kerosene (kerosine) -liquid mixture: aromatics---------- 15.9% cycloparaffins ------ 52.8% paraffins ---------- 30.8% alkenes ---------- 0.5%	B	0	3	0	May cause irritation of eyes, mucous membranes, skin, and lungs with prolonged or repeated exposure; overexposure may affect the central nervous system and cause heartbeat irregularities; flammable mixture.	B, D2	5	3	WF/I

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kinetin ---------- solid $C_{10}H_9N_5O_{(s)}$	A	0	0	0	May cause irritation of the skin, eyes, respiratory, and digestive tracts.	NC	8	NR	T
Knop's reagent ---- solution mixture: $MgSO_4 \cdot 7H_2O$ ------ 1.0g KH_2PO_4 ---------- 0.2g KNO_3 ---------- 1.0g $Ca(NO_3)\ 4H_2O$ --- 1.0g $FeCl_3$ (1% sol) ---- 1.0 drop H_2O ---------- 1.0 L	A	1	0	0	May cause irritation of the skin, eyes, respiratory, and digestive tract.	D2	8	NR	D
lactic acid - crystals/liquid (*2-hydroxypropanoic acid*) $C_3H_6O_{3(s)}$ or $CH_3CHOHCOOH_{(s)}$	B	3	1	0	Corrosive; causes irritation and burns to any area of contact; harmful if swallowed or inhaled; extremely destructive to tissue of the skin, eyes, mucous membranes and respiratory tract; crystals combustible if heated or ignited.	E	3	8	WF/I or N/P-D
lactose--- crystals/powder $C_{12}H_{22}O_{11(s)}$	A	0	1	0	Dust may cause eye and skin irritation; Dust-air mixture explosive, combustible solid if heated.	NC	8	NR	T
lauric acid --------- crystals (d*odecanoic acid*) $C_{12}H_{24}O_{2(s)}$ or $CH_3(CH_2)_{10}COOH_{(s)}$	B	1	1	0	May cause irritation of the skin, eyes, respiratory, and digestive tract; combustible if heated or ignited, fine dust – air mixture explosive.	D2	3	NR	WF/I or N/P-D
lead metal ---------- strips $Pb_{(s)}$	A –strips B-powder	3	0	0	Toxic, particularly the dust or powder; dust causes irritation to skin, eyes, and respiratory tract; may be fatal if swallowed or if dust inhaled; a neurotoxin with prolonged exposure but also affects the kidneys, blood and reproductive system; possible human carcinogen dependent on duration and level of exposure.	D2	8	9	R

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lead(II) nitrate ---- powder $Pb(NO_3)_{2(s)}$	B	2	0	0 OX	May cause skin, eye, and respiratory tract irritation; may cause digestive tract irritation with nausea, vomiting and diarrhea; can be fatal if enough dust is inhaled or if ingested; neurotoxin with chronic or prolonged exposure, affects the central nervous system, kidneys, blood and reproductive system; strong oxidizer.	C, D1, D2	6	5.1 (6.1)	WF/I
Lead compounds (other than nitrate)-------- powders	C	3	0	0	Toxic; cause skin, eye, and respiratory tract irritation; may be fatal if swallowed or inhaled; neurotoxin with chronic or prolonged exposure, also affect the kidneys, blood, liver, and reproductive system; Pb phosphate and Pb acetate are a cancer hazard in humans.	D1, D2	8	6.1	WF/I
lime water --------- solution mixture: $Ca(OH)_2$ ---------- 0.16% H_2O ---------- 99.84% $Ca(OH)_{2\ (aq)}$	A	0	0	0	May cause irritation of the skin, eyes, respiratory, and tract.	NC	8	NR	D
lithium ---------- solid $Li_{(s)}$	C	3	2	1 W	Corrosive; causes eye and skin burns; may cause severe respiratory or digestive tract irritation or burns; may cause kidney damage and central nervous effects; light sensitive; reacts with water; flammable solid.	B, E	4	4.3	WF/I
lithium acetate dihydrate ---------- crystals $LiCH_3COO{\bullet}2H_2O_{(s)}$	A	2	0	0	Causes eye irritation; may cause irritation of the skin, respiratory, and digestive tracts; harmful if swallowed, inhaled, or adsorbed through skin; may cause kidney damage and central nervous effects	D2	8	NR	T

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lithium bromide --- crystals anhydrous $LiBr_{(s)}$	A	2	0	0	May be harmful if swallowed; causes eye, skin and respiratory tract irritation; chronic or excessive intake may cause kidney, cardiac and central nervous system effects and/or damage.	D2	8	NR	WF/I
lithium carbonate- powder $Li_2CO_{3(s)}$	A	2	0	0	May cause irritation of the skin, eyes, respiratory, and digestive tracts; harmful if swallowed or inhaled, affects the central nervous system, muscles, and kidneys.	D2	8	NR	T
lithium chloride --- crystals $LiCl_{(s)}$	A	2	0	0	Causes irritation of the skin, eyes, and respiratory tract, skin irritation may be severe; harmful if swallowed or inhaled, affects the central nervous system, muscles, and kidneys.	D2	8	NR	T
lithium fluoride ---- crystals $LiF_{(s)}$	B	2	0	0	May cause severe eye and skin irritation and possible burns; causes respiratory or digestive tract irritation; may cause kidney damage, central nervous effects, cardiac disturbances, and skeletal abnormalities	D2	8	6.1	WF/I
lithium hydroxide monohydrate ------ crystals $LiOH•H_2O_{(s)}$	B	3	0	0	Corrosive; causes burns to any area of contact; may be fatal if swallowed or inhaled.	D1, E	2	8	WF/I or N/P-D
lithium iodide ----- crystals $LiI_{(s)}$	B	2	0	0	May be harmful if swallowed; causes eye, skin and respiratory tract irritation; chronic or excessive intake may cause kidney, cardiac and central nervous system effects and/or damage.	D2	8	6.1	WF/I

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lithium nitrate ---- granular $LiNO_{3(s)}$	C	2	0	3 OX	Causes irritation to skin, eyes, and respiratory tract; harmful if swallowed or inhaled, affects the central nervous system, respiratory system, muscles, and kidneys; strong oxidizer, contact with combustible material may cause fire; dangerous explosive risk when shocked or heated.	C, D1, D2	6	5.1	WF/I
lithium sulfate ----- crystals $Li_2SO_4 \cdot H_2O_{(s)}$	B	2	0	0	May cause irritation to skin, eyes, and respiratory tract; harmful if inhaled or swallowed; affects muscles, lungs, central nervous system, and kidneys.	NC	8	NR	T or D(aq)
litmus blue -------- powder (*lichenblue*) formula (variable)	A	2	0	0	Causes irritation to skin, eyes, and intestinal tract; may be harmful if swallowed, inhaled, or adsorbed through skin.	NC	8	NR	T
Lugol's iodine stain ---------- solution (B*ouchardat's reagent*) mixture: I_2 ---------- 5% KI ---------- 10% CH_3COOH ----- 10% H_2O ---------- 75%	B	2	0	1	Causes irritation to skin, eyes, and respiratory tract, may burn skin on contact; harmful if swallowed or inhaled; chronic low-level ingestion may cause mental depression, nervousness, insomnia, and sexual impotence.	D2	7	8 (9e)	WF/I
lycopodium ------- powder (*club moss spores, vegetable sulfur)* formula not applicable	B	1	2	0	Causes eye and gastro-intestinal tract irritation, may cause irritation of the skin and respiratory tract; possible allergen; flammable powder, easily ignited by open flame, can produce an explosive flash.	D2	8	4.1	WF/I

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magnesium --------- powder $Mg_{(s)}$	B	0	1	1 W	May cause skin, eye, and respiratory tract irritation; flammable solid, burning releases UV light and heat; may react with water to form explosive hydrogen gas.	B, D2	8	4.1	WF/I
magnesium ---------- strips $Mg_{(s)}$	A	0	1	1	Flammable solid if heated, releases UV light and heat upon burning.	B, D2	8	4.1	R
magnesium acetate---------- powder $Mg\ (CH_3COO)_2 \bullet 4H_2O_{(s)}$	A	1	0	0	May cause irritation to eyes, and respiratory tract.	NC	8	NR	T or D(aq)
magnesium bromide ---------- granular $MgBr_{2(s)}$	A	2	0	0	Causes irritation to skin, eyes, respiratory and digestive tracts; may be harmful if swallowed, inhaled, or absorbed through skin.	D2	8	NR	T
magnesium carbonate ---------- powder $MgCO_{3(s)}$	A	1	0	0	May cause irritation to skin, eyes, and respiratory and digestive tracts.	NC	8	NR	T
magnesium chloride hexahydrate ------- crystals $MgCl_2 \bullet 6H_2O_{(s)}$	A	2	0	0	May be harmful by ingestion, inhalation, or skin absorption.	NC	8	NR	T
magnesium hydroxide ---------- powder $Mg(OH)_{2(s)}$	A	1	0	0	May cause irritation to skin, eyes, digestive, and respiratory tracts.	D2	2?	NR	WF/I or N/P-D
magnesium nitrate hexahydrate ------- crystals $Mg(NO_3)_2 \bullet 6H_2O_{(s)}$	A	2	0	0 ox	Causes irritation to skin, eyes, and respiratory tract; may be harmful if swallowed or inhaled; strong oxidizer, contact with combustible material may cause fire.	C, D2	6	5.1	WF/I

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magnesium oxide - powder $MgO_{(s)}$	A	1	0	0	May cause irritation to skin, eyes, and respiratory tract.	NC	8	NR	T
magnesium(IV) oxide ---------- powder (*magnesium peroxide*) $MgO_{2(s)}$	B	2	0	0 OX	May cause irritation to skin, eyes, mucous membranes, and upper respiratory tract; may be harmful if swallowed, inhaled, or absorbed through skin; oxidizer, contact with combustible material may cause fire.	C	6	5	T
magnesium sulfate heptahydrate ------- powder (*epsom salts*) $MgSO_4 \bullet 7H_2O_{(s)}$	A	1	0	0	Dust may be slightly irritating to respiratory system, may be harmful if swallowed.	NC	8	NR	T
magnetite ---------- chunks (*Iron oxide*) $Fe_3O_{4(s)}$	A	1	0	0	May cause irritation to skin, eyes, and respiratory tract; prolonged inhalation of dust or fumes may lead to metal fume fever.	NC	8	NR	T
malachite green--- solution mixture: water ---------- 55% malachite green ----- 45%	A	2	0	0	Harmful if swallowed; contact with skin, eyes, digestive and respiratory tracts may cause irritation, risk of severe eye damage.	NC	8	8	WF/I
malachite green --- crystals (*aniline green, China green, benzaldehyde green*) $C_{23}H_{25}N_2Cl_{(s)}$	B	2	1	1	Harmful if swallowed; contact with skin or eyes may cause irritation and eye damage; flammable if heated, light sensitive.	NC	8	6.1 (8)	WF/I
malachite green --- crystals (*aniline green, China green, benzaldehyde green*) $C_{48}H_{50}N_4O_4 \bullet 2HC_2O_{4(s)}$	B	2	0	0	Harmful by inhalation or ingestion; irritates skin, eyes, and mucous membranes.	NC	6.1, 8	NR	WF/I

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maleic acid ---------- solid (*butenedioic acid, toxilic acid*) $C_4H_4O_{4(s)}$	C	3	1	1	Corrosive; causes skin and severe eye irritation and possible burns; may cause severe digestive, and respiratory tract irritation and possible burns; may be harmful if swallowed or absorbed through skin; may cause kidney damage; combustible if heated.	E	3	8	WF/I or N/P-D
maleic anhydride --- lumps (*2,5-furandione*) $C_4H_2O_{3(s)}$	C	3	1	1	Corrosive; causes burns to skin and eyes; causes respiratory tract irritation and possible burns, digestive tract irritation with nausea and diarrhea; harmful if swallowed; combustible if heated, dust-air mixture explosive; decomposes slowly with water to form maleic acid.	E	4, 3, 8	8	WF/I
malic acid —------ crystals (*hydroxybutanedioic acid*) $C_4H_6O_{5(s)}$	B	1	1	0	Causes irritation to skin, eyes, and respiratory tract; may be harmful if swallowed; combustible at elevated temperatures or if ignited, dust-air mixture explosive.	NC	3	NR	WF/I or N/P-D
malonic acid ------- crystals (*propanedioic acid*) $CH_2(COOH)_{2(S)}$	B	1	1	0	Causes irritation to eyes, may cause irritation to skin and respiratory tract; may be harmful if swallowed; combustible at elevated temperatures or if ignited, dust-air mixture explosive.	NC	3	NR	WF/I or N/P -D
maltose ---------- granules $C_{12}H_{22}O_{11(s)}$	A	0	1	0	No adverse effects; combustible if heated or ignited, dust-air mixture explosive.	NC	8	NR	T or D (aq)

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manganese—powder/solid $Mn_{(s)}$	A	2	1	1	Powder may cause irritation to skin, eyes and respiratory tract; harmful if swallowed or inhaled, causing chronic damage to health; chronic exposure affects the central nervous system; dust is flammable; decomposes slowly in contact with water.	NC	8	NR	R /T-solid WF/I-powder
manganese(II) carbonate hydrate ---------- powder $MnCO_3 \bullet XH_2O_{(s)}$	A	1	0	0	May cause irritation to skin, eyes, digestive and respiratory tracts; chronic inhalation affects the central nervous system.	NC	8	NR	WF/I or N/P-D
manganese(II) chloride tetrahydrate ------- crystals $MnCl_2 \bullet 4H_2O_{(s)}$	A	2	0	0	May cause irritation to skin, eyes, and respiratory tract; harmful if swallowed or inhaled; affects lungs, central nervous system, blood and kidneys.	D2	8	NR	T or D (aq)
manganese(IV) oxide---------- powder (*manganese dioxide*) $MnO_{2(s)}$	A	2	0	1 OX	Causes skin and eye irritation; harmful if inhaled, ingested, or absorbed through skin; may affect central nervous system; oxidizing agent, may cause fire in contact with combustible material.	C, D2	6	5.1	WF/I or N/P-D
manganese sulfate monohydrate ------ granular $MnSO_4 \bullet H_2O_{(s)}$	A	2	0	0	May cause irritation to skin, eyes, and respiratory system; harmful if swallowed or inhaled; affects lungs, central nervous system, blood and kidneys.	D2	8	NR	T or D (aq)
D-mannose -------- crystals (*seminose, carubinose*) $C_6H_{12}O_{6(s)}$	A	0	1	0	No adverse affects; will burn if heated and dust-air mixture explosive.	NC	8	NR	T or D (aq)
marble chips ---------- chips (*calcium carbonate)* $CaCO_{3(s)}$	A	1	0	0	Dust may cause irritation to skin, eyes, and respiratory system.	NC	8	NR	T

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menthol ---------- solid (*hexahydrothymol*) $C_{10}H_{20}O_{(s)}$	A	0	0	0	May cause irritation of the eyes, skin, respiratory and digestive tracts.	NC	8	NR	T or D (aq)
mercury ---------- liquid (*quicksilver*) $Hg_{(l)}$	C	3	0	0	Corrosive; causes burns to skin, eyes, and respiratory tract; may be fatal if swallowed or inhaled, harmful if absorbed through skin; chronic exposure affects the central nervous system and kidneys.	D2	8	8	R or WF/I
mercury compounds	C	3	0	0	Toxic	D2	8	6.1	WF/I
methane -------- gas/liquid (natural gas) $CH_{4(g)}$ & $CH_{4(l)}$	B	1	4	0	Excessive inhalation may cause difficulty breathing, nausea, dizziness, suffocation or coma; extremely flammable, will produce explosive mixture with air.	B	5	2.1	WF/I or RS-cyl.
methionine --------- crystals (*acimethin*) $C_5H_{11}NO_2S_{(s)}$	A	1	1	0	Dust may cause irritation to skin, eyes, digestive, and respiratory tract; may cause reproductive and fetal effects; flammable if heated or exposed to flame.	NC	8	NR	WF/I
methyl alcohol(99%)--liquid *(methanol, gas line antifreeze)* $CH_3OH_{(l)}$	B	2	3	0	Causes eye, skin, and respiratory tract irritation; harmful if swallowed, inhaled or absorbed through skin; highly flammable.	B, D1, D2	5	3 (6.1)	WF/I
methylbenzene ------- liquid (*toluene, phenylethane)* $C_7H_{8(l)}$	B	2	3	0	Irritant to skin, eyes, respiratory and digestive tract; harmful or fatal if swallowed; may cause liver and kidney damage; may cause adverse reproductive and fetal effects; highly flammable.	B, D2	5	3	WF/I
methylcellulose ------- solid (*cellulose methyl ether*) $C_7H_{14}O_5X_{(s)}$	A	0	0	0	No adverse effects.	NC	8	NR	T

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methylene blue ---- crystals (b*asic Blue 9*) $C_{16}H_{18}ClN_3S{\cdot}3H_2O_{(s)}$	A	2	1	0	Dust may cause mechanical irritation of eyes; harmful if swallowed, no adverse effects if inhaled; combustible if heated or ignited, dust-air mixture explosive.	NC	8	NR	T or D (aq)
methylene blue---- solution mixture: water ---------- 99.-% methylene blue ------<1.0% $C_{16}H_{18}ClN_3S_{(aq)}$	A	0	0	0	May cause irritation to eyes; no other adverse effects.	NC	8	NR	D
methylene chloride -- liquid (d*ichloromethane*) $CH_2Cl_{2(l)}$	C	2	1	0	May cause irritation to skin and eyes, excessive inhalation may irritate the upper respiratory tract; prolonged contact causes serious kidney and liver damage; flammable if heated; human carcinogen.	D1, D2	5	6.1	WF/I
methyl ethyl ketone --liquid (*2-butanone*) $C_4H_8O_{(l)}$ or $CH_3COCH_2CH_{3(l)}$	C	2	3	0	Causes mild irritation to skin, vapour causes moderate irritation to eyes, nose, and respiratory tract; higher than 350 ppm exposure causes central nervous system depression, very high concentrations cause unconsciousness and possible death; flammable liquid, vapour-air mixture explosive.	B, D2	5	3	WF/I
2-methyl,1-propanol- liquid (*iso-butyl alcohol)* $C_4H_{10}O_{(l)}$ or $(CH_3)_2CHCH_2OH_{(l)}$	B	2	3	0	Causes irritation to skin, eyes, and respiratory tract; may be harmful if swallowed, inhaled, or ingested; affects the central nervous system; flammable liquid and vapour.	B, D2	5	3	WF/I
methyl orange ------- solid (*C.I. acid orange 52*) $C_{14}H_{14}N_3NaO_3S_{(s)}$	B	2	0	0	May cause irritation of the skin, eyes, and respiratory tract; harmful by skin absorption, inhalation or ingestion.	D1, D2	8	6.1	WF/I

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methyl orange ---- solution mixture: water ---------- 99.9% methyl orange ------ 0.1% $C_{14}H_{14}N_3NaO_3S$ (aq)	A	1	0	0	May cause irritation of the skin, eyes, and respiratory tract; excessive exposure may be harmful by skin absorption, inhalation or ingestion.	NC	8	NR	WF/I
methyl red ---------- solid (*C.I. acid red*) $C_{15}H_{15}N_3O_{2(s)}$	B	1	1	0	May cause skin, eye, digestive, and respiratory tract irritation; chronic exposure may causes liver damage.	NC	8	NR	WF/I
methyl red --------- solution mixture: methyl alcohol ----- 99.98% methyl red ---------- 0.02% $C_{15}H_{15}N_3O_2$ (aq)	B	2	3	0	Causes eye, skin, and respiratory tract irritation; harmful if swallowed, inhaled or absorbed through skin; highly flammable.	D2	5	3 (6.1)	WF/I
methyl salicylate ----- liquid (*wintergreen oil, betula oil*) $C_8H_8O_{3(l)}$	A	2	1	0	Causes irritation of the skin, eyes, and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; affects the kidneys and central nervous system.	D2	8	NR	WF/I
methyl violet ------- solution mixture: water ---------- 99.98% methyl violet ------- 0.02% $C_{24}H_{28}N_3Cl_{(aq)}$	A	1	0	0	May cause mild irritation to skin, eyes, digestive and respiratory tracts.	NC	8	6.1	WF/I
methyl violet ------- crystals (*C.I.basic violet 1*) $C_{24}H_{28}N_3Cl_{(s)}$	A	2	0	0	Causes irritation to skin and eyes; harmful if swallowed or inhaled.	NC	8	6.1	WF/I
mica ---------- sheets (*muscovite, micro,dry ground, wet ground mica*) $KAl_2Si_3O_{10}(OH)_25H_2O_{(s)}$	A	1	0	0	Dust may irritate eyes and respiratory tract; chronic lung damage results from extended inhalation; respirable particles of quartz are hazardous to inhale.	NC	8	NR	R or T

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
Million's reagent -- solution mixture: mercury ---------- 25% nitric acid ---------- 50% water---------- 25%	C	3	0	0	Toxic; causes burns to skin, eyes, respiratory and digestive tracts; extremely corrosive to mucous membranes; may cause reproductive effects; may cause teratogenic effects.	D1, E	1	6.1 (8)	WF/I
Mohr's salt -------- crystals (*ammonium ferrous sulfate*) $FeH_8N_2O_8S_{2(s)}$	B	2	1	0	May cause irritation of the skin, eyes, respiratory and intestinal tracts if taken internally; harmful by ingestion, inhalation or skin absorption; flammable if heated.	D1	8	9	WF/I or N/P-D
molybdenum metal ---------- powder $Mo_{(s)}$	A	1	0	0	May be irritating to skin, eyes, nose, throat, and respiratory tract; dust-air mixture could be explosive with strong ignition.	NC	8	NR	WF/I
naphthalene ------ crystals (*moth balls, tar camphor*) $C_{10}H_{8(s)}$	C	3	2	0	Toxic; irritating to eyes, skin, and respiratory system; harmful by inhalation, ingestion, or skin contact; possible human carcinogen; flammable.	B, D2	4	4.1	WF/I
nichrome wire -------- solid mixture (alloy): nickel -------- 80-90% chromium – 10-20%	A	1	0	0	Solid metal forms of nickel and chromium have no adverse effects.	NC	8	NR	R
nickel ---------- powder $Ni_{(s)}$	C	1	1	1	Powder may cause irritation to skin, eyes, and respiratory tract; causes gastrointestinal irritation with nausea, vomiting and diarrhea if ingested; powder pyrophoric- can ignite spontaneously; human carcinogen.	D2	4	4.1	WF/I
nickel ---------- strip $Ni_{(s)}$	A	0	0	0	Stable, no adverse effects.	NC	8	NR	R

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
nickel(II) chloride nexahydrate ------- crystals $NiCl_2 \cdot 6H_2O_{(s)}$	C	2	0	0	Causes irritation to skin, eyes, respiratory tract; harmful if swallowed or inhaled; human carcinogen.	D1, D2	8	6.1	WF/I or N/P-D
nickel(II) nitrate hexahydrate ------- crystals $Ni(NO_3)_2 \cdot 6H_2O_{(s)}$	C	1	0	0 OX	Causes irritation to skin, eyes, respiratory tract; harmful if swallowed or inhaled; strong oxidizer, contact with combustible material may cause fire; human carcinogen.	C, D2	6	5.1	WF/I or N/P-D
nickel(II) sulfate hexahydrate —---- crystals $NiSO_4 \cdot 6H_2O_{(s)}$	C	1	0	0	Irritant to skin, eyes, and mucous membranes, chronic exposure causes "nickel itch", intestinal disorders, convulsions and asphyxia; has reproductive effects; mutagenic and human carcinogen.	D2	8	NR	WF/I or N/P -D
ninhydrin monohydrate ------- powder $C_9H_6O_{4(s)}$	B	2	1	0	Irritating to skin, eyes, and respiratory tract; harmful if swallowed; combustible if heated or ignited, powder-air mixture explosive.	D2	8	NR	T
nitric acid --------- solution mixture: HNO_3 ---------- 62-75% H_20 ---------- 25-38% $HNO_{3\ (aq)}$	B	3	0	0 OX	Corrosive; liquid and vapour causes severe damage to skin, eyes, and mucous membranes; strong oxidant.	C, D1	1, 6	8 (5.1)	WF/I or N/P-D
nitrobenzene —- oily liquid (*nitrobenzol, oil of mirbane*) $C_6H_5NO_{2(l)}$	C	3	2	1	Toxic; may be fatal if swallowed, inhaled, or absorbed through skin; causes irritation to skin and eyes; affects blood, liver, kidneys, and reproductive system; possible cancer hazard; combustible liquid and vapour.	B, D1, D2	5	6.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
nitrogen -------liquefied gas $N_{2(l)}$ & $N_{2(g)}$	B	2	0	0	Skin and eye contact with liquid causes cryogenic burns; gas non-toxic but in confined spaces, will displace oxygenated air and cause asphyxiation.	A	8	2.2	A
nitrogen dioxide---------liquefied gas $NO_{2(l)}$ & $NO_{2(g)}$	C	4	0	0 OX	Very toxic & corrosive, short term exposure causes irritation and possible burns to skin, eyes, and respiratory tract; potentially fatal if inhaled; strong oxidizer, contact with combustible material may cause fire.	D1, C	6	2.3 (5.1) (8)	WF/I
octyl acetate ---------- liquid (*2-ethylhexyl acetate*) $C_{10}H_{20}O_{2(l)}$	A	1	2	0	Causes skin and eye irritation, may cause respiratory and digestive tract irritation; combustible liquid.	B	5	NR	WF/I or RS – cyl.
octyl alcohol ---------- liquid (*n-octanol, caprylic alcohol*) $C_8H_{18}O_{(l)}$	B	2	2	0	Causes irritation to skin, eye, and respiratory tract, may be harmful if swallowed or inhaled; affects the CNS; combustible liquid and vapour.	B, D1	5	NR	WF/I
oleic acid -------- oily liquid ((*z*)-*9-octadecenoic acid*) $C_{18}H_{34}O_{2(l)}$	A	1	1	0	Causes irritation to skin, eyes, digestive tract and respiratory tract, if mist is inhaled; combustible if pre-heated and ignited.	NC	3	NR	WF/I or N/P-D
orangeIV ---------- powder (*tropaeolin OO, C.I. 13080*) $C_{18}H_{14}N_3NaO_3S_{(s)}$	B	2	1	0	May cause irritation to skin, eyes, and respiratory tract; may be harmful by skin absorption, inhalation or ingestion; combustible if heated or ignited, powder-air mixture explosive.	D2	8	NR	T
orangeIV --------- solution mixture : water ---------- 99.9% orangeIV ---------- 0.1% $C_{18}H_{14}N_3NaO_3S_{(aq)}$	A	1	0	0	May cause irritation to skin, eyes, and respiratory tract; may be harmful by skin absorption or ingestion with excessive exposure or intake.	NC	8	NR	D

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
orcein ---------- powder $C_{28}H_{24}N_2O_{7(s)}$	A	1	0	0	May cause irritation to skin, eyes, respiratory and digestive tracts.	NC	8	NR	T
oxalic acid --------- crystals (*ethanedioic acid*) $C_2H_2O_{4(s)}$	C	3	1	0	Corrosive; causes severe irritation to skin, eyes and respiratory tract; harmful if inhaled or absorbed through skin, may be fatal if ingested; may cause kidney damage; combustible solid below 101°C.	D1, E	3	8	WF/I or N/P-D
oxygen ---------- gas $O_{2(g)}$	A	0	0	0 ox	No adverse effects; supports combustion, accelerates burning.	A, C	6	2.2 (5.1)	A
palmitic acid --------crystals (h*exadecanoic acid*) $C_{16}H_{32}O_{2(s)}$	A	1	1	0	Causes irritation to skin, eyes, respiratory and digestive tracts; combustible if heated or ignited, dust-air mixture explosive.	NC	3	NR	WF/I or N/P-D
pancreatin ---------- powder (diastase vera) (variable composition)	B	1	1	0	Causes irritation to skin, eyes, respiratory tracts; combustible if heated or ignited	NC	8	NR	T
paradichloro – benzene ------ ------crystals (*1,4-dichlorobenzene*) $C_6H_4Cl_{2(s)}$	C	2	2	0	Causes irritation to skin, eyes, and respiratory tract; harmful if inhaled, swallowed, or absorbed through the skin; affects the respiratory system, liver, kidneys, and blood; flammable, forms explosive vapour-air mixture; possible human carcinogen.	D1, D2	4	9	WF/I
paraffin ---------- solid $C_nH_{2n+2(s)}$	A	1	1	0	May cause mild irritation to eyes, and digestive tract; dust or fumes may irritate the respiratory tract; flammable.	NC	8	NR	T
paraformaldehyde-powder $(CH_2O)_{n(s)}$	C	3	1	1	Corrosive ; causes severe irritation to skin, eyes, respiratory and digestive tracts and possible burns, releases formaldehyde when dissolved in water; flammable solid.	B, D1, D2	8	4.1	WF/I or N/P-D

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Chemical Name (s), State and Formula	Use In School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
pentane (n) ---------- gas $C_5H_{12(g)}$	C	2	4	0	Causes irritation to skin, eyes, and respiratory tract; harmful if inhaled or ingested; highly flammable liquid.	B, D1	5	3	WF/I
pentyl alcohol -------- liquid (*amyl alcohol*, *1- pentanol*) $C_5H_{11}OH_{(l)}$	B	2	3	0	Liquid irritates the skin and causes severe irritation or eyes with possible burns, vapours cause severe irritation of the respiratory tract; harmful if inhaled, swallowed or absorbed through skin; affects the nervous system; flammable liquid and vapour.	B, D2	5	3	WF/I
pentyl (*iso*) alcohol -- liquid (*iso-amyl alcohol*) $C_4H_{10}O_{(l)}$ or $(CH_3)_2CHCH_2CH_2OH_{(l)}$	B	2	2	0	Causes irritation to skin, mucous membranes, and respiratory tract, severe irritant to eyes; harmful if swallowed, inhaled, or ingested; hematotoxic; affects the central nervous system; flammable liquid and vapour, emits toxic fumes when burned.	B, D2	5	3	WF/I
pepsin ---------- powder (variable composition)	B	1	1	0	May causes irritation to skin and eyes; combustible if heated or ignited.	NC	8	NR	T
perchloric acid --- solution mixture: $HClO_4$ ---- 70% H_2O ------- 30% $HClO_{4\ (aq)}$	C	3	0	3 ox	Corrosive; causes severe burns at site of contact; very harmful through skin contact, inhalation, and ingestion; unstable, will decompose explosively at higher temperatures or if allowed to dehydrate, contact with wood, paper and other cellulose products may lead to explosion; strong oxidizer.	C, E	1, 6	5.1 (8)	WF/I or N/P-D

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
petroleum ether —---- liquid mixture: n-pentane --------- 85+% methylpentane -- small % cyclopentane ---- small % dimethylbutane—small % other hydrocarbons------ variable	C	2	4	0	Irritating to skin, eyes, and respiratory system; harmful by inhalation, ingestion, or skin contact; extremely flammable liquid.	B, D1	5	3	WF/I
phenol ---------- solid (*carbolic acid, phenic acid*) $C_6H_6O_{(s)}$	C	4	2	0	Corrosive and toxic; causes severe burns to any area of contact; may be fatal if swallowed, inhaled, or absorbed through skin; absorbed rapidly through skin; affects CNS, liver, and kidneys; causes adverse reproductive and fetal effects; flammable	B, D1, D2	3, 4, 5	6.1	WF/I
phenolphthalein -- needles $C_{20}H_{14}O_{4(s)}$	B	1	1	0	May cause skin, eye, digestive, and respiratory tract irritation; prolonged exposure may have adverse reproductive effects; may be carcinogenic; combustible at higher temperatures or if ignited.	NC	8	NR	T
phenolphthalein --solution mixture: phenolphthalein 0.5 -1.0% ethyl alcohol --- 50 – 95% methyl alcohol -----1 – 2 % isopropyl alcohol - 1 – 2%	B	2	3	0	May cause skin, eye, digestive, and respiratory tract irritation; prolonged exposure may have adverse reproductive effects; may be carcinogenic; combustible at higher temperatures or if ignited.	B	5	3	WF/I
phenol red —------- solution mixture: water ---------- 73 –75% ethanol ---------- 24 - 26% phenol red -------- < 1.0%	B	1	2	0	May cause irritation to skin, eyes, digestive, and respiratory tracts; flammable vapour; excessive intake may depress the central nervous system.	NC	5	NR	D

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
l-phenylalanine -- crystals $C_9H_{11}NO_{2(s)}$	A	1	0	0	Skin, eye, and respiratory tract irritant.	NC	8	NR	T
phenylhydrazine ---- liquid (*hydrozinobenezene*) $C_6H_8N_{2(l)}$	C	3	2	0	Corrosive; causes irritation of respiratory tract and burns to any area of contact; harmful if swallowed, inhaled, or absorbed through skin; affects blood, liver, kidneys, and respiratory system; combustible solid, liquid and vapour.	B, D2	5	6.1	WF/I
phenyl salicylate -- crystals (*2-hydroxybenzoic acid, phenyl ester*) $C_{13}H_{10}O_{3(s)}$ or $C_6H_4(OH)COC_6H_{5(s)}$	B	2	0	0	May cause skin, eye, digestive, and respiratory tract irritation; overexposure may cause reproductive disorders.	D2	8	NR	WF/I
phenylthiocarbamide paper (phenylthiourea, *PTC paper*) $C_7H_8N_2S_{(s)}$	B	3	1	0	Toxic; exposure to larger amounts very toxic by inhalation, skin contact, or if swallowed; minute amounts in PTC paper not a serious danger; paper flammable.	D1	8	6.1	T
phosphoric acid -- solution mixture: H_3PO_4 ---------- 74 – 95% H_2O ---------- 5 – 26% $H_2PO_{4\ (aq)}$	B	3	0	0	Corrosive; causes severe irritation and burns to any area of contact; harmful if swallowed or fumes inhaled.	E	1	8	WF/I or N/P -D
phosphorus, amorphous red ---- powder $P_{(s)}$	B	2	1	1	Causes eye irritation; may be harmful if swallowed or fumes inhaled; flammable solid, may ignite from friction.	B	8	4.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
phosphorus, purified yellow ---------- waxy solid (white phosphorus) $P_{4(s)}$	C	3	4	2	Corrosive; causes severe skin and eye burns; harmful if absorbed through skin; acute inhalation causes serious damage to lungs and respiratory tract; may be fatal if swallowed; extremely flammable, ignites spontaneously on exposure to air, fumes from burning phosphorus extremely irritating.	B, D1	4	4.2	WF/I
phosphorus pentoxide ---------- powder (*phosphoric anhydride*) $P_2O_{5(s)}$	C	3	0	3 ~~W~~	Corrosive; fumes cause irritation to eyes and respiratory tract; causes burns to any area of contact; harmful if swallowed or inhaled; reacts violently with water to form phosphoric acid.	D1, E	8	8	WF/I
phosphorus trichloride ---- fuming liquid $PCl_{3(l)}$	C	3	0	2 ~~W~~ ox	Corrosive; causes severe burns to any area of contact; may be fatal if swallowed or inhaled; reacts with water; strong oxidizer, contact with other material may cause fire.	C, D1	8	5.1 (8)	WF/I
phthalic acid -------- powder (*1,2-benzenedicarboxylic acid*) $C_8H_6O_{4(S)}$	B	1	1	1	Causes irritation of skin, eyes, respiratory and digestive tracts; decomposes if heated, powder- air mixture explosive.	NC	3	NR	WF/I or N/P-D
picric acid ---------- crystals (*2,4,6-trinitrophenol*) $C_6H_3N_3O_{7(s)}$	C	3	4	4	Toxic; causes skin and respiratory tract irritation, and severe eye irritation; harmful if swallowed, inhaled, or absorbed through the skin; affects the liver, kidneys and blood; stable in water but explosive if allowed to dry, becomes increasingly shock, heat, and friction sensitive as moisture lost; flammable solid.	B, D1, D2, F	3, 4	4.1	WF/I or N/P-D

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
platinum (metal) ------- solid $Pt_{(s)}$	A	1	1	0	May cause irritation of skin, eye, respiratory and digestive tracts; flammable solid.	NC	8	NR	R
polyethylene ---------- solid $[C_2 H_4]_{n(s)}$	A	1	1	0	Dust a respiratory tract and a mechanical eye irritant; combustible if heated or ignited.	NC	8	NR	R
polypropylene ---------- solid $[C_3 H_6]_{n(s)}$	A	1	1	0	Dust may be an eye and respiratory tract irritant; combustible at high temperatures.	NC	8	NR	R
polystyrene ---------- solid *(dylene)* $[C_8 H_8]_{n(s)}$	A	1	1	0	Dust an upper respiratory irritant and a mechanical eye irritant; combustible if heated or ignited.	NC	8	NR	R
polyvinyl acetate ------ solid *(PVA)* $(C_4H_6O_2)_{n(s)}$	A	0	0	0	Nor adverse effects.	NC	8	NR	R, T
polyvinyl alcohol-- granules $[CH_2CHOH]_{n(s)}$	B	0	2	0	Nuisance dust, mechanical irritation of eyes; flammable if ignited or heated, may form combustible dust concentrations in air.	NC	8	NR	R or T
potassium (metal) —- solid $K_{(s)}$	C	3	3	2 ~~W~~	Corrosive; causes burns to all areas in contact; harmful or fatal if swallowed; harmful if absorbed through skin; water reactive; flammable solid, ignites when exposed to air.	B, D1, E	4	4.3	WF/I
potassium acetate- powder $KCH_3COO_{(s)}$	A	1	0	0	May cause mild irritation to the skin, eyes, and respiratory tract.	NC	8	NR	T or D (aq)

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potassium bromate ---------- powder $KBrO_{3(s)}$	C	3	0	1 OX	Toxic; causes irritation to skin, eyes, and respiratory tract; harmful if dust inhaled or absorbed through skin, may be fatal if swallowed; may cause kidney damage; strong oxidizer, may ignite combustible material.	C, D1, D2	6	5.1	WF/I
potassium bromide ---------- crystals $KBr_{(s)}$	B	2	0	0	May cause irritation of the skin, eyes, and respiratory tract; harmful if swallowed or inhaled; affects the central nervous system, and eyes.	D2	8	NR	T
potassium carbonate ---------- powder $K_2CO_{3(s)}$	A	2	0	0	Causes severe irritation to skin, eyes, and respiratory tracts; harmful if swallowed or inhaled.	D2	8	NR	T
potassium chlorate ---------- powder $KClO_{3(s)}$	C	2	0	3 OX	Causes irritation to skin, eyes, and respiratory tracts; harmful if swallowed, may cause methemoglobinemia, liver or kidney damage; strong oxidizer, contact with other material may cause fire; decomposes when heated releasing oxygen gas, may explode.	C, D2	6	5.1	WF/I
potassium chloride ---------- crystals $KCl_{(s)}$	A	1	0	0	May cause severe irritation to skin, eyes, and respiratory tract.	NC	8	NR	T
potassium chromate ---------- crystals $K_2CrO_{4(s)}$	C	3	0	1 OX	Corrosive; causes severe burns to area of contact; harmful if swallowed or inhaled; affects the respiratory system, liver, kidneys, eyes, skin, and blood; strong oxidizer, contact with other material may cause fire; releases oxygen gas upon decomposition; human carcinogen.	C, D1, D2	6	5.1 (8)	WF/I or N/P-D

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
potassium dichromate ---------- powder $K_2Cr_2O_{7(s)}$	C	3	0	1 OX	Corrosive; causes severe burns to area of contact; harmful if swallowed or inhaled; affects the respiratory system, liver, kidneys, eyes, skin, and blood; strong oxidizer, contact with other material may cause fire; releases oxygen gas upon decomposition; human carcinogen.	C, D1, D2	6	5.1 (8)	WF/I or N/P-D
potassium dihydrogen-phosphate, --------- crystals (*potassium phosphate, monobasic*) $KH_2PO_{4(s)}$	A	1	0	0	May cause irritation to eyes, skin, respiratory and digestive tracts.	NC	8	NR	WF/I
potassium ferrocyanide ------- powder $K_3Fe(CN)_{6(s)}$	B	2	0	1	May cause irritation to skin, eye, and respiratory tract; may be harmful if swallowed or inhaled; decomposes if heated releasing cyanide gases.	NC	8	NR	WF/I
potassium hydrogen-carbonate ---------- crystals (*potassium bicarbonate*) $KHCO_{3(s)}$	A	1	0	0	May be a mild irritant to skin, eyes, digestive, and respiratory tracts.	NC	8	NR	T or D (aq)
potassium hydrogen-oxalate- powder or crystals (*potassium binoxalate*) $KHC_2O_{4(s)}$	A	1	0	0	Causes irritation of the skin, eyes, respiratory and digestive tracts; harmful if swallowed.	D1, D2	8	NR	T or D (aq)
potassium hydrogen-phosphate ---------- powder (*potassium phosphate, dibasic*) $K_2HPO_{4(s)}$	A	1	0	0	May be harmful if swallowed.	NC	8	NR	WF/I

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potassium hydrogen-phthalate ---------- powder $KH_5C_8O_{4(s)}$	B	1	1	0	May cause irritation to skin, eyes, and respiratory tract; combustible if heated or ignited, air-dust mixture explosive	NC	8	NR	T or D (aq)
potassium hydrogen-sulfate ---------- powder (*potassium bisulfate*) $KHSO_{4(s)}$	C	3	0	0	Corrosive; causes burns to any area of contact; may be harmful if swallowed.	E	8	8	WF/I
potassium hydrogen-tartrate ---------- powder (*potassium bitartrate, cream of tartar*) $KHC_4H_4O_{6(s)}$	A	0	0	0	No adverse effects.	NC	8	NR	T or D (aq)
potassium hydroxide----------pellets (*caustic potash*) $KOH_{(s)}$	B	3	0	1	Corrosive; causes severe burns to any area of contact; harmful by ingestion, inhalation, or skin contact; unstable, absorbs carbon dioxide and moisture from air.	D1, E	2	8	WF/I or N/P-D
potassium iodate -- powder $KIO_{3(s)}$	C	2	0	3 OX	May cause severe irritation to skin, eyes, and respiratory tract with possible burns; may cause kidney damage and central nervous system effects ; strong oxidizer, enhances combustion of other substances; can be explosive if exposed to heat or flames, mechanical shock, or friction.	C, D2	6	5.1	WF/I or N/P-D
potassium iodide -- crystals $KI_{(s)}$	A	1	0	1	May cause irritation to skin, eyes, respiratory, and digestive tracts; may cause fetal effects ; light and moisture sensitive.	D2	8	NR	T or D (aq)

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
potassium nitrate-- crystals $KNO_{3(s)}$	B	2	0	0 OX	Causes irritation of the skin, eyes, and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; strong oxidant, may cause fire in contact with combustible material.	C, D2	6	5.1	WF/I
potassium nitrite-- granules $KNO_{2(s)}$	B	2	0	0 OX	Causes severe irritation of the skin, eyes, and respiratory tract; harmful or fatal if swallowed, harmful if inhaled or absorbed through skin; strong oxidant, may cause fire in contact with combustible material; will decompose under extreme heat.	C, D2	6	5.1	WF/I
potassium oxalate–crystals $K_2C_2O_4 \cdot H_2O_{(s)}$	C	4	0	0	Corrosive and toxic; causes severe burns to every area of contact; may be fatal if swallowed, ingestion of 15-30 grams by adult is lethal within minutes to a few hours; harmful if inhaled.	D1, D2	8	6.1	T or D (aq)
potassium permanganate ---- crystals (*Condy's crystals*) $KMnO_{4(s)}$	B	3	0	1 OX	Corrosive; dust causes severe irritation and burns to skin, eyes, and mucous membranes of the digestive and respiratory tracts; chronic exposure may impair the central nervous system; strong oxidizing agent, may ignite combustible materials; may decompose if heated above 150°C causing explosion.	C, E	6	5.1	WF/I or N/P-D
potassium phosphate, monobasic ---------- powder $KH_2PO_{4(s)}$	A	1	0	0	May causes irritation to eyes, skin, and respiratory tract; may be harmful if swallowed or inhaled.	NC	8	NR	WF/I
potassium phosphate, dibasic ---------- powder $K_2HPO_{4(s)}$	A	1	0	0	No adverse effects to eyes, skin, or respiratory tract; may be harmful if swallowed.	NC	8	NR	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
potassium phosphate, tribasic ---------- powder $K_3PO_4 \cdot xH_2O_{(s)}$	B	2	0	0	Causes irritation and possible burns to eyes, skin, respiratory, and digestive tract; harmful if swallowed or inhaled.	E	8	8 (6.1)	WF/I
potassium sodium tartrate ---------- powder (R*ochelle salt*) $KNaC_4H_4O_6 \cdot 4H_2O_{(s)}$	A	1	1	0	May cause irritation to eyes, skin, and respiratory tract; combustible if heated or ignited, dust-air mixture explosive.	NC	8	NR	T or D (aq)
potassium sulfate-- powder $K_2SO_{4(s)}$	A	1	0	0	May produce mechanical irritation to eyes and irritation to skin, respiratory and digestive tracts.	D2	8	NR	T or D (aq)
potassium sulfide-- powder $K_2S_{(s)}$	C	3	1	2	Toxic; very destructive to mucous membranes, causes burns; harmful by inhalation, ingestion, or through skin contact; flammable, anhydrous form may be spontaneously combustible; reacts with acids to release toxic H_2S.	D1, D2	8	4.2 (6.1)	WF/I
potassium sulfite--- crystals $K_2SO_{3(s)}$	B	2	0	0	Irritating to skin, eyes, and respiratory system; may be harmful if swallowed, inhaled or absorbed through skin.	D2	8	NR	T or D (aq)
potassium thiocyanate --------- crystals $KSCN_{(s)}$	B	2	0	0	Causes irritation to eyes, skin, and respiratory tract; harmful if swallowed or inhaled.	D2	8	NR	WF/I
L- proline ---------- powder $C_5H_9NO_{2(s)}$	A	1	0	0	May cause irritation to skin, eyes, respiratory, and digestive tracts.	NC	8	NR	T or D (aq)
propane ---------- liquid/gas $C_3H_{8(l)}$ or $C_3H_{8(g)}$	B	1	4	0	May be harmful if inhaled, asphyxiant at high concentrations; highly flammable, vapours heavier than air and collect in low areas or along the floor; liquid gas can cause freeze burns.	A & B	5	2.1	RS WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
n-propanol ---------- liquid (*n-propyl alcohol, rubbing alcohol*) $C_3H_8O_{(l)}$ or $CH_3(CH_2)_2OH_{(l)}$	B – small volume	2	3	0	Causes irritation of the skin, eyes, and respiratory tract; harmful if swallowed, inhaled or absorbed through skin, may affect the central nervous system; flammable liquid and vapour	B, D2	5	3	D or WF/I
propionic acid --- oily liquid (*propanoic acid, methyl acetic acid*) $C_3H_6O_{2(l)}$ or $CH_3CH_2COOH_{(l)}$	C	3	2	0	Corrosive; causes severe irritation and burns to skin, eyes, respiratory and digestive tracts; extremely destructive to mucous membranes, harmful if absorbed through skin, inhaled, or ingested; flammable liquid; mutagen.	B, D1	3, 5	8	WF/I or N/P-D
sec-propyl alcohol --- liquid (*iso-propyl alcohol*) $C_3H_8O_{(l)}$ or $(CH_3)_2CHOH_{(l)}$	B	2	3	0	Causes irritation to eyes and respiratory tract; harmful if swallowed, inhaled, or absorbed through skin; affects the central nervous system; flammable liquid and vapour.	B	5	3	WF/I
propylene glycol -oily liquid (*1, 2 propanediol*) $C_3H_8O_{2(l)}$ or $CH_3CHOHCH_2OH_{(l)}$	A	0	1	0	May cause irritation to skin and eyes; combustible if heated or ignited.	NC	8	NR	WF/I
prussic acid --------- liquid (*hydrogen cyanide, anhydrous, hydrocyanic acid*) $HCN_{(l)}$	C	4	4	2	Highly toxic; vapour irritates skin, eyes, and mucous membranes; short term exposure leads to death by rapid absorption through skin or by inhalation; also toxic by ingestion; flammable fumes.	B, D1, D2, E	1, 5	6.1	WF/I
P.T.C.- embedded in paper (*phenylthiocarbamide, phenylthiourea*) $C_7H_8N_2S_{(s)}$	B	3	1	0	Toxic; exposure to larger amounts very toxic by inhalation, skin contact, or if swallowed; minute amounts in PTC paper not a serious danger; paper flammable.	D1	8	6.1	T

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
pyridine ---------- liquid (*azabenzene*) $C_5H_5N_{(l)}$	C	3	3	0	Corrosive; causes severe irritation and burns to skin, eyes, respiratory and digestive tracts; harmful if absorbed through skin, inhaled, or ingested, may be fatal; long-term exposure may cause liver, kidney or central nervous system damage; reacts violently with some acids and oxidizing agents; flammable liquid, flash point 19 C.	B, D2, E	5	3	WF/I or N/P-D
pyrite ---------- chunks (*Iron disulfide*) $FeS_{2(s)}$	A	2	1	0	Dust irritating to skin, eyes, and respiratory tract; ingestion leads to release hydrogen sulfide by a reaction with stomach acid; prolonged inhalation may lead to pulmonary fibrosis, damage to kidneys and liver, fine powder flammable.	NC	8	NR	T
pyrogallol ---------- powder *(pyrogallic acid, 1,2,3-benzenetriol)* $C_6H_6O_{3(s)}$	B	2	1	0	Causes irritation to skin, eyes, and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; affects the respiratory system, liver, kidneys, eyes, skin, and blood; combustible if ignited or heated.	D2	3	6.1 (8)	WF/I
quartz ---------- crystalline (*silica*) $Si_{(s)}$	A	1	0	0	Dust or granules can be a mild skin irritant, prolonged overexposure to dust leads to silicosis; may be carcinogenic.	NC	8	NR	R or T
quinaldine red ------ powder $C_{21}H_{23}IN_{2(s)}$	B	2	0	0	May cause irritation; may be harmful if inhaled, ingested, or absorbed via skin.	NC	8	NR	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
quinine sulfate dihydrate ---------- powder (*quinicardine*) $(C_{20}H_{24}N_2O_2)_2\ H_2SO_4 \cdot H_2O_{(s)}$	B	2	1	0	May cause irritation to skin, eyes, and respiratory tract; harmful if swallowed, may be harmful if inhaled; prolonged exposure affects the cardiovascular and central nervous system; flammable if heated or ignited, dust-air mixture explosive.	D2	8	NR	WF/I
Rennett tablets -------- solid (rennin) (variable composition)	A	0	1	0	May cause irritation of the eyes, chronic exposure may produce an allergenic sensitization in susceptible individuals.	NC	8	NR	T
resorcinol --------- powder (*1,3-benzenediol*) $C_6H_6O_{2(s)}$	C	3	1	0	Toxic; causes severe irritation to skin and eyes, less to the respiratory tract; harmful if absorbed through skin or inhaled, may be fatal if ingested; long-term exposure affects liver, kidneys, cardiovascular system, central nervous system and spleen; combustible if ignited or heated.	D1, D2	8	6.1	WF/I
rhodanine ---------- crystals (r*hodanic acid*) $C_3H_3NOS_{2(s)}$	B	2	1	0	May cause irritation to skin, respiratory and digestive tracts, irritant to eyes; harmful if swallowed; combustible at elevated temperatures or if ignited, dust-air mixture explosive.	D2	8	NR	WF/I
Rochelle salt --------powder (p*otassium sodium tartrate*) $KNaC_4H_4O_6 \cdot 4H_2O_{(s)}$	A	1	1	0	May cause irritation to eyes, skin and respiratory tract; combustible at elevated temperatures or if ignited, dust-air mixture explosive.	NC	8	NR	T or D(aq)
rosolic acid ------- powder (a*urin*) $(HOC_6H_4)_2C{:}C_6H_4{:}O_{(s)}$	B	1	1	0	Irritant to eyes, skin and respiratory tract; combustible at elevated temperatures or if ignited, dust-air mixture explosive.	NC	3	NR	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
rubbing alcohol ------- liquid (*n-propyl alcohol*, n-propanol) $C_3H_8O_{(l)}$ or $CH_3(CH_2)_2OH_{(l)}$	B – small volume	2	3	0	Causes irritation of the skin, eyes, and respiratory tract; harmful if swallowed, inhaled or absorbed through skin, may affect the central nervous system; flammable liquid and vapour	B, D2	5	3	D or WF/I
safranin O ---------- solution mixture: water ---------- 98.8% sodium benzoate --- 0.2% safranin O ---------- 1.0%	A	1	0	0	May irritate the eyes and skin. No other adverse effects.	NC	8	NR	D
safranin O ---------- powder $C_{20}H_{19}N_4Cl_{(s)}$	A	1	0	0	Dust irritates the eyes and skin. No other adverse effects.	NC	8	NR	WF/I
salicylic acid--------crystals (*2-hydroxybenzoic acid*) $C_7H_6O_{3(l)}$ or $HOC_6H_4COOH_{(l)}$	B	2	1	0	Causes irritation to skin, eyes, and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; affects the central nervous system, kidneys, and pancreas; combustible at elevated temperatures, dust-air mixture explosive.	D1, D2	3	NR	WF/I or N/P-D
selenium ---------- shot $Se_{(s)}$	B	2	0	0	Dust causes severe irritation to skin, eyes, and respiratory tract; dust harmful if swallowed or inhaled; affects the liver, kidneys, blood, and spleen.	D1	8	NR	WF/I
serine ---------- powder $C_3H_7NO_{3(s)}$	A	1	0	0	May cause irritation to skin, eyes, digestive and respiratory tracts.	NC	8	NR	T or D (aq)
silicic acid --------- granules (*silica gel*) $H_2SiO_{3(s)}$	A	1	0	0	May cause irritation to skin, eyes, digestive and respiratory tracts.	NC	3	NR	T

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silicon ---- crystals/powder $Si_{(s)}$	B-crystal C-powder	1	3	0	May cause irritation to skin, eyes, digestive, and respiratory tracts; may cause central nervous system depression; flammable powder.	B, D2	4	4.1	WF/I
silicon dioxide ---- granules (*silica, quartz, sand)* $SiO_{2(s)}$	A	2	0	0	May cause eye irritation; harmful if dust inhaled, carcinogenic over extended period of inhalation.	D2	8	NR	T
silver (metal) ---------- solid and foil $Ag_{(s)}$	A	0	0	0	Dust may cause mild skin, eye, or mucous membrane irritation; prolonged exposure can cause permanent blue-grey staining of eyes, skin, nose, mouth, and throat.	NC	8	NR	R
silver acetate ------- powder $AgC_2H_3CO_{2(s)}$	A	1	0	0	Causes irritation to skin, eyes, and respiratory tract, may cause digestive tract irritation	D2	8	NR	N/P -R
silver bromide ------ powder $AgBr_{(s)}$	A	1	0	0	May cause irritation to skin, eyes, and digestive tract.	D2	8	NR	N/P -R
silver chloride ------ powder $AgCl_{(s)}$	A	1	0	0	May cause irritation to skin, eyes, and digestive tract, causes respiratory tract irritation.	D2	8	NR	N/P -R
silver nitrate ------- crystals $AgNO_{3(s)}$	B	3	0	0 OX	Corrosive; causes burns to any area of contact; may be fatal if swallowed, harmful if inhaled; strong oxidizer, contact with combustible material may cause fire.	C, D1, E	6	5.1	N/P -R
silver oxide ---------- powder $Ag_2O_{(s)}$	A	2	0	1 OX	Contact with skin and eyes causes severe irritation and possible burns, may cause irritation of the respiratory tract; harmful if swallowed; strong oxidizer, contact with combustible material may cause fire; absorbs CO_2 from air.	C, D2	6	5.1	N/P-R
silver sulfate-------- crystals $Ag_2SO_{4(s)}$	A	1	0	0	May cause irritation to skin, eyes, respiratory, and digestive tract.	D2	8	NR	N/P -R

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
soda lime ---------- pellets mixture: ethyl violet ------ < 1% NaOH ---------- < 2% KOH ---------- < 3% $Ca(OH)_2$ -------- > 80%	B	3	0	0	Corrosive; causes severe burns to any area of contact; causes severe irritation to respiratory tract ; harmful if swallowed or inhaled ; absorbs CO_2 from air to form calcium carbonate.	NC	2	8	WF/I or N/P-D
sodium (metal) -------- solid $Na_{(s)}$	C	3	3	2 W	Corrosive; contact may cause burns; harmful if metal absorbed through skin, harmful or fatal if ingested; flammable solid, ignites spontaneously in air; reacts violently with water releasing explosive hydrogen gas.	B, E	4	4.3	N/P-D or WF/I
sodium acetate anhydrous & trihydrate---------- crystals $CH_3COONa_{(s)}$ & $CH_3COONa{\bullet}3H_2O_{(s)}$	A	1	1	0	May cause skin, eye and respiratory tract irritation; combustible if heated or ignited, particle-air mixture explosive.	D2	8	NR	T or D (aq)
sodium arsenite --- powder $NaAsO_{2(s)}$	C	3	0	0	Toxic; causes irritation to skin, eyes, and respiratory tract; may be fatal by ingestion or inhalation; may cause liver and kidney damage; carcinogen.	D2	8	6.1	WF/I
sodium benzoate -- powder $C_6H_5COONa_{(s)}$	A	1	1	0	May cause skin, eye, and respiratory tract irritation; ignition possible if heated, dust – air mixture explosive.	NC	8	NR	T
sodium borate ------ powder decahydrate (*borax*) $Na_2B_4O_7{\bullet}10H_2O_{(s)}$	A	2	0	0	Causes irritation of the eyes, skin, and respiratory tract; harmful if swallowed, inhaled or absorbed through skin.	NC	8	NR	T or D (aq)
sodium bromate --- powder $NaBrO_{3(s)}$	B	2	0	1 OX	Causes irritation to eyes, skin, digestive, and respiratory tracts, oxidizing agent.	C, D1	6	5.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
sodium bromide -- granules $NaBr_{(s)}$	B	2	0	0	May cause irritation to eyes, skin, and respiratory tract; harmful if swallowed; affects the central nervous system and eyes.	NC	8	NR	D
sodium carbonate anhydrous --------- granular $Na_2CO_{3(s)}$	A	2	0	0	May cause eye and skin irritation with possible burns and irritation of respiratory and digestive tracts; harmful if inhaled or swallowed.	D1, D2	8	NR	T or D (aq)
sodium chlorate --- crystals $NaClO_{3(s)}$	B	2	0	2 OX	Causes irritation to eyes, skin, and respiratory tract, harmful if swallowed; may cause damage to blood, liver or kidneys; strong oxidizing agent, contact with combustible material may cause fire.	C, D1	6	5.1	WF/I or N/P-T
sodium chloride -- granules $NaCl_{(s)}$	A	1	0	0	Dust may cause irritation to eyes, skin, and respiratory tract.	NC	8	NR	T or D (aq)
sodium chromate tetrahydrate --------- powder $Na_2CrO_4 \cdot 4H_2O_{(s)}$	C	3	0	1 OX	Corrosive; causes severe burns to any area of contact; harmful if swallowed or inhaled ; affects the respiratory system, kidneys, eyes, skin, and blood; strong oxidizer, contact with combustible material may cause fire; human carcinogen.	C, D1, D2	6	5.1 (8)	N/P-T or WF/I
sodium citrate ------ powder dihydrate $Na_3C_6H_5O_7 \cdot 2H_2O_{(s)}$	A	1	0	0	May cause irritation to eyes, skin, digestive, and respiratory tracts.	NC	8	NR	T or D (aq)

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sodium dichromate dihydrate ---------- powder $Na_2Cr_2O_7 \cdot 2H_2O_{(s)}$	C	3	0	2 OX	Corrosive; causes burns to skin, eyes, respiratory and digestive tracts; may be fatal if swallowed, harmful if inhaled or if absorbed through skin; causes cardiac disturbances, may cause blood and kidney damage; strong oxidizer, may cause fire if in contact with combustible material; human carcinogen.	C, D1, D2	6	6.1 (8)	WF/I or N/P-D
sodium dihydrogen-phosphate ---------- crystals *(sodium phosphate monobasic dihydrate)* $NaH_2PO_4 \cdot 2H_2O_{(s)}$	A	1	0	0	May cause irritation of the skin, eyes, respiratory and digestive tracts.	NC	8	NR	WF/I
sodium ethanoate--crystals (so*dium acetate*) $CH_3COONa_{(s)}$ & $CH_3COONa \cdot 3H_2O_{(s)}$	A	1	1	0	May cause skin, eye and respiratory tract irritation; combustible if heated or ignited, particle-air mixture explosive.	D2	8	NR	T or D (aq)
sodium fluoride ---- crystals $NaF_{(s)}$	C	3	0	0	Toxic; causes irritation to skin and eyes, and severe irritation to respiratory tract, irritation effects may be delayed; may be fatal if swallowed or inhaled; prolonged exposure affects the respiratory, circulatory, central nervous system, and kidneys and may cause mottling of teeth and bone damage.	D1, D2	8	6.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
sodium hydrogen-carbonate ---------- powder (*sodium bicarbonate, baking soda*) $NaHCO_{3(s)}$	A	1	0	0	May cause slight irritation of the eyes, skin, and respiratory tract.	NC	8	NR	T or D (aq)
sodium hydrogenphosphate anhydrous —------ granules *(sodium hydrogen phosphate dibasic*) $Na_2HPO_{4(s)}$	A	1	0	0	May cause irritation to skin, eyes, and respiratory tract.	NC	8	NR	WF/I
sodium hydrogensulfate monohydrate ------- crystals (*sodium bisulfate*) $NaHSO_4 \cdot H_2O_{(s)}$	C	3	0	2 W	Corrosive; causes burns to any area of contact; may be harmful or fatal if swallowed; causes severe irritation and burns to respiratory tract; reacts violently with moisture in air or with water or steam.	E	8	8	WF/I
sodium hydrogensulfite (*sodium bisulfite*)- granules mixture: $NaHSO_{3(s)}$-------- 58 – 99% $Na_2SO_{5(s)}$ -------- 1 – 42%	B	2	0	1	Causes irritation to eyes, skin, and respiratory tract; harmful if swallowed or inhaled, reacts with acids and water releasing toxic SO_2 gas; oxidizes to the sulfate on exposure to air and moisture.	d2	8	NR	WF/I
sodium hydroxide--- pellets (*caustic soda*) $NaOH_{(s)}$	B	3	0	1	Corrosive; causes burns to any area of contact, may be fatal if swallowed; harmful if inhaled; heat released when added to water.	D1, E	2	8	WF/I or N/P-D

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sodium hydroxide- solution (*caustic soda*) mixture: H_2O ---------- 80 - 90% NaOH ---------- 10 – 20 % $NaOH_{(aq)}$	A – 5% or less B – more than 5%	3	0	1	Corrosive; causes burns to any area of contact, may be fatal if swallowed; harmful if inhaled; heat released when added to water.	D1, E	2	8	WF/I or N/P-D
sodium hypochlorite -------- solution (*bleach)* mixture: H_2O ----------80 – 99% NaClO---------- 1 – 20% $NaOCl_{(aq)}$	B	2	0	2 OX	Skin irritant, may cause burns to skin and eyes; harmful by inhalation, ingestion, or through skin contact; light and temperature sensitive, decomposes with release of chlorine gas; oxidizer.	C, D1	6	8	D
sodium iodate ------ powder $NaIO_{3(s)}$	B	2	0	1 OX	Causes irritation to skin, eyes, and respiratory tract; harmful if swallowed or inhaled; strong oxidizer, may cause fire in contact with combustible material; may explode with strong mechanical shock or friction .	C	6	5.1	WF/I
sodium iodide ------ crystals $NaI_{(s)}$	B	2	0	1	Causes irritation to skin, eyes, and respiratory tract; harmful if swallowed or inhaled; chronic exposure produces "iodism" with headache, fever, laryngitis, bronchitis, and iodine mumps; absorbs moisture; decomposes if heated releasing toxic fumes of iodine and sodium oxide. Note: Added to table salt for iodine source.	D2	8	NR	T or D (aq)

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
sodium metabisulfite ------ granules $Na_2S_2O_{5(s)}$	B	2	0	1	Causes irritation to eyes, skin, and respiratory tract; harmful if swallowed or inhaled, slowly oxidizes to the sulfate on exposure to air and moisture; reacts with acids and water releasing toxic SO_2 gas.	D2	8	NR	D (aq) or WF/I
sodium metasilicate pentahydrate ------- powder $Na_2SiO_3 \cdot 5H_2O_{(s)}$	B	3	0	0	Corrosive when wet; severe irritant to skin, causes rapid burns to eyes and severe burns to mouth, throat and stomach if ingested, harmful if inhaled.	D2, E	8	8	WF/I or N/P-D
sodium nitrate ----- crystals $NaNO_{3(s)}$	B	2	0	1 OX	May cause irritation to eyes, skin, and respiratory tract; harmful if swallowed or inhaled; strong oxidizer, contact with combustible material may cause fire; decomposes explosively if heated to >538°C or with severe impact.	C, D2	6	5.1	WF/I
sodium nitrite ----- granules $NaNO_{2(s)}$	B	2	0	1 OX	Causes irritation to eyes, skin, and respiratory tract; harmful if swallowed, inhaled, or absorbed through skin; strong oxidizer, contact with combustible material may cause fire; explosion risk if heated to 537°C or with severe impact.	C, D1, D2	6	5.1	WF/I
sodium oxalate ---- powder $Na_2C_2O_{4(s)}$	C	3	0	0	Corrosive; causes burns to any area of contact; harmful if inhaled, may be fatal if ingested; may affect the kidneys.	D1, D2	8	6.1 (8)	WF/I
sodium peroxide --granules $Na_2O_{2(s)}$	C	3	0	1 OX W	Corrosive; causes burns to any area of contact; harmful if swallowed or inhaled; reacts with water; strong oxidizer, contact with combustible material may cause fire.	C, D1, D2	6	5.1	WF/I

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sodium phosphate tribasic dodecahydrate -- crystals $Na_3PO_4 \cdot 12H_2O_{(s)}$	B	2	0	1 W	Causes irritation of the skin, eyes, and respiratory tract; harmful if swallowed or inhaled; reacts with water.	NC	8	NR	WF/I
sodium propionate- powder $NaC_3H_5O_{2(s)}$ or $CH_3CH_2COONa_{(s)}$	A	1	0	0	Causes irritation of the skin and eyes.	NC	8	NR	T or D (aq)
sodium silicate ----- powder (*water glass*) $Na_2SiO_{3(s)}$	B	3	0	0	Corrosive; causes severe burns to any area of contact, harmful if swallowed or inhaled.	D2	8	8	WF/I
sodium silicate nanohydrate -------- powder (*water glass*) $Na_2SiO_3 \cdot 9H_2O_{(s)}$	B	3	0	0	Corrosive; causes severe irritation to skin, eyes, and respiratory tract; harmful if swallowed or inhaled.	D2	8	8	WF/I
sodium sulfate ----- powder $Na_2SO_{4(s)}$	A	1	0	0	May cause irritation of skin, eye, respiratory and digestive tract.	NC	8	NR	T or D (aq)
sodium sulfide nonahydrate -------- crystals $Na_2S \cdot 9H_2O_{(s)}$	C	3	0	1	Corrosive; causes severe burns to any area of contact, harmful if swallowed or inhaled; decomposes in contact with moisture and acids forming toxic combustible hydrogen sulfide gas.	B, D1	8	8	WF/I
sodium sulfite ------ crystals $Na_2SO_{3(s)}$	A	2	0	0	May cause irritation of skin, eye, and respiratory tract; harmful if swallowed.	D2	8	NR	WF/I
sodium tetraborate decahydrate -------- crystals (*sodium borate, borax*) $Na_2B_4O_7 \cdot 10H_2O_{(s)}$	A	2	0	0	May cause irritation of skin, eye, respiratory and digestive tract, may cause adverse reproductive effects.	NC	8	NR	T or D (aq)

Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
sodium thiocyanate --------- crystals $NaSCN_{(s)}$	B	2	0	1	Causes irritation to skin, eyes, and respiratory tract; harmful if swallowed or inhaled; may affect heart, blood, thyroid, and central nervous system; decomposes on exposure to light.	D1, D2	8	6.1	WF/I
sodium thiosulfate--crystals $Na_2S_2O_{3(s)}$	B	2	0	0	May cause irritation of skin, eye, and respiratory tract; may be harmful if swallowed or inhaled.	D2	8	NR	T or D (aq)
starch ---------- powder $(CH_2O)_{n(s)}$	A	0	1	0	May cause irritation to skin, eyes, and respiratory tract; may form explosive dust-air mixture.	NC	8	NR	T
stearic acid --------- powder (*octadecanoic acid)* $C_{18}H_{36}O_{2(s)}$ or $CH_3(CH_2)_{16}COOH_{(s)}$	A	1	1	0	May cause irritation of skin, eye, and respiratory tract; combustible if heated or ignited, air-dust mixture explosive.	NC	3	NR	WF/I or N/P-D
strontium ---------- solid $Sr_{(s)}$	C	3	4	2 W	Corrosive; contact may cause burns; harmful or fatal if swallowed; flammable solid, granules ignite spontaneously with air; reacts with water.	D2, E	4	4.3	WF/I
strontium acetate hemihydrate--------- crystals $SrC_4H_6O_4 \cdot 0.5\ H_2O_{(s)}$	A	0	0	0	No adverse effects	NC	8	NR	T
strontium chloride hexahydrate -------- powder $SrCl_2 \cdot 6H_2O_{(s)}$	B	2	0	0	May cause irritation of skin, eye, and respiratory tract; may be harmful if swallowed or inhaled.	D2	8	NR	WF/I or N/P-D
strontium nitrate --- powder $Sr(NO_3)_{2(s)}$	B	2	0	0 OX	Causes irritation of skin, eyes, and respiratory tract; harmful if swallowed, inhaled, or absorbed through skin; strong oxidant, fire risk in contact with organic material.	C, D2	6	5.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
styrene ---------- oily liquid (*ethenylbenzene*) $C_8H_{8(l)}$	B	2	3	2	Causes irritation of skin, eyes, and respiratory tract; harmful if swallowed, inhaled, or absorbed through skin; affects the central nervous system, liver, and reproductive system; flammable liquid and vapour; stabilized form polymerizes at room temperature.	B, D1, D2	5	3	WF/I
succinic acid ------- crystals (*butanedioic acid* $C_4H_6O_{4(s)}$ or $HOOCCH_2CH_2COOH_{(s)}$	A	1	1	0	Causes irritation of skin, eyes, and respiratory tract, irritation to eyes may be severe; combustible if heated or ignited, air-dust mixture explosive	D2	3	NR	T or D (aq)
sucrose ---------- crystals $C_{12}H_{22}O_{11(s)}$	A	0	1	0	High concentration of dust may irritate the eyes and respiratory tract; combustible if heated or ignited, air-dust mixture explosive.	NC	8	NR	T or D (aq)
sudan III ---------- powder $C_{22}H_{16}N_4O_{(s)}$	A	0	1	0	No adverse health affects; combustible if heated or ignited, dust-air mixture explosive	NC	8	NR	WF/I
sudan IV ---------- powder $C_{24}H_{20}N_4O_{(s)}$	A	0	1	0	May cause skin, eye, and respiratory tract irritation; combustible if heated or ignited, dust-air mixture explosive.	NC	8	NR	WF/I
sulfamic acid ------- crystals (*amidosulfonic acid*) $H_3NO_3S_{(s)}$	C	3	0	0	Corrosive; causes severe irritation and burns to every area of contact; may be fatal if swallowed harmful if inhaled.	D2, E	3	8	WF/I
sulfur ---------- solid $S_{8(s)}$	B	2	1	0	Dust irritating to skin, eyes, and respiratory system; may be harmful if absorbed through skin, inhaled or ingested; sulfur dust- air mixture explosive; combustible if heated or ignited releasing toxic sulfur dioxide.	D2	8	4.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
sulfuric acid —------ solution mixture: H_2SO_4 ---------- 52 – 100% H_2O ---------- 0 – 48% $H_2SO_{4\ (aq)}$	A - 5% or less B – more than 5%	3	0	2 W	Corrosive; liquid and mist causes severe burns to all body tissues; may be fatal if swallowed or contacted with skin; harmful if inhaled; water reactive, releasing heat; cancer hazard with prolonged exposure to sulfuric acid mist.	D1, D2, E	1	8	WF/I or N/P-D
sulfurous acid ------ solution (h*ydrogen sulfite*) mixture: H_2SO_3 ---------- 6 – 12% H_2O ---------- 88 – 94% $H_2SO_{3(aq)}$	A – 5% or less B – more than 5%	3	0	0	Corrosive with prolonged contact, causes burns to any area of contact; harmful if inhaled or ingested.	D1, D2, E	8	8	N/P-D
tannic acid ---------- powder (*tannin*) $C_{76}H_{52}O_{46(s)}$	A	2	1	0	Causes irritation to skin, eyes, and respiratory tract; may be harmful if swallowed or inhaled; large amounts can cause liver and kidney damage; combustible if heated or ignited, dust-air mixture explosive.	D1, D2, E	3	NR	WF/I
L-tartaric acid ----- crystals (*2,3-dihydroxy-butanedioic acid*) $C_4H_6O_{6(s)}$	A	1	1	0	May cause irritation to skin and eyes; combustible if heated or ignited, dust-air mixture explosive.	E	3	NR	N/P-D or WF/I
tetrachloroethylene -- liquid (*ethylene tetrachloride*) $Cl_2CCCl_{2(l)}$	B	2	0	0	Harmful if swallowed, inhaled, or absorbed through skin; causes irritation to skin, eyes and respiratory tract; severe or prolonged exposure affects the central nervous system, liver, and kidneys; may be a human carcinogen.	D1, D2	1	6.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
thallium metal --------- solid $Tl_{(s)}$	C	3	0	0	Toxic metal; may be fatal by absorption through skin, ingestion, or by inhalation of dust. Ingestion leads to nausea, vomiting, convulsions and death due to central nervous system damage; prolonged or repeated exposure may result in hair loss, kidney damage, paralysis and death.	D1, D2	8	6.1	WF/I
thioacetamide ----- crystals (*ethanethioamide*) $C_2H_5NS_{(s)}$	A	2	1	0	Causes irritation to skin, eyes, and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; possible carcinogen; combustible if heated or ignited, dust-air mixture explosive.	D1, D2	8	NR	WF/I
thorium ---------- solid $Th_{(s)}$	C	3	0	0	Toxic, radioactive element; avoid skin contact or inhalation of dust.	D1, D2	8	6.1	WF/I
thymol blue --------- powder (*thymolsulfonephthalein*) $C_{27}H_{30}O_5S_{(s)}$	A	1	1	0	May cause irritation to skin, eyes, and respiratory tract; combustible if heated or ignited	NC	8	NR	WF/I
thymolphthalein --- crystals $C_{28}H_{30}O_{4(s)}$	A	1	0	0	May cause irritation to skin, eyes, and respiratory tract.	NC	8	NR	WF/I
tin(II) chloride —-- crystals $SnCl_{2(s)}$	A	2	0	0	May cause severe eye and respiratory tract irritation, and digestive tract irritation with nausea, vomiting, and diarrhea; may cause liver damage; hygroscopic	D2	8	8	WF/I
tin metal ---------- granules or mossy flakes $Sn_{(s)}$	A	1	1	1	May cause irritation to skin, eyes, and respiratory tract; oxidizes especially in presence of moisture; dust-air mixture explosive.	NC	8	NR	T

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
tin(II) oxide -------- powder $SnO_{(s)}$	A	1	0	0	May cause irritation to skin, eyes, and respiratory tract; may cause digestive tract irritation with nausea, vomiting, and diarrhea, may cause central nervous system effects.	NC	8	NR	T
tin(IV) oxide ------- powder $SnO_{2(s)}$	A	1	0	0	May cause irritation to skin, eyes, digestive and respiratory tracts.	D2	8	NR	T
tin(II) sulfate ------- powder $SnSO_{4(s)}$	A	2	0	0	May cause irritation to skin and respiratory tract, causes irritation to skin and digestive tract with nausea, vomiting, and diarrhea; may cause central nervous system and reproductive effects; moisture sensitive.	D2	8	NR	T or D (aq)
titanium(IV) chloride---------- powder $TiCl_{4(s)}$	C	3	0	2 W	Corrosive; causes severe irritation and burns to every area of contact; may be fatal if inhaled, may cause lung damage; harmful if ingested; water reactive.	D2, E, F	8	6.1 (8)	WF/I
titanium metal ---------- solid $Ti_{(s)}$	A	1	0	0	Relatively non-toxic, dust can cause mild irritation of the respiratory system; dust-air mixture explosive.	NC	8	NR	R or T
titanium(IV) oxide - powder $TiO_{2(s)}$	A	1	0	0	May cause irritation to skin, eyes, and respiratory tract.	NC	8	NR	T
toluene ---------- liquid (*methylbenzene*) $C_7H_{8(l)}$	B	2	3	0	Causes irritation to skin, eyes, and respiratory tract; harmful if inhaled, or absorbed through skin, harmful or fatal if swallowed; may affect the liver, kidneys, blood system or central nervous system; flammable liquid and vapour.	B, D2	5	3	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
1,1,1-trichloroethane- liquid (*methylchloroform*) $C_2H_3Cl_{3(l)}$ or $CH_3CCl_{3(l)}$	B	2	1	1	Causes irritation of the skin, eyes, and respiratory tract; harmful if swallowed, inhaled, or absorbed through skin; affects the central nervous system, liver, kidneys, and cardiovascular system; possible carcinogen; hydrolyzes slowly in water to form hydrochloric and acetic acids; combustible if heated or ignited.	D2	8	6.1	WF/I
1,1,2-trichloro-1,2,2-trifluoroethane -------- liquid (freon) $CCl_2FCClF_{2(l)}$	C	2	0	0	Causes irritation to eyes and respiratory tract; harmful if inhaled; affects the cardiovascular and central nervous systems.	D2	8	9	WF/I
triethanolamine ----- liquid (*trolamine*) $C_6H_{15}NO_{3(l)}$ or $(HOCH_2CH_2)3N_{(l)}$	B	2	1	1	Causes skin irritation and severe irritation of the eyes; harmful if swallowed, chronic exposure may lead to liver and kidney damage; flammable, air-vapour mixture explosive; light and air sensitive.	D1	8	NR	WF/I
trisodium phosphate---------- crystals (sodium phosphate tribasic, TPS) $Na_3PO_4 \cdot 12H_2O_{(s)}$	A	2	0	1 W	Causes irritation of the skin, eyes, and respiratory tract; harmful if swallowed or inhaled; reacts with water.	NC	8	NR	WF/I
tryptophan ---------- crystals $C_{11}H_{12}N_2O_{2(s)}$	A	1	0	0	May be irritating to skin, eyes, respiratory and digestive tracts.	NC	8	NR	T
tungsten ---------- solid $W_{(s)}$	A	1	2	1	Dust may cause irritation to skin, eyes, digestive and respiratory tracts; flammable solid, may ignite spontaneously in air.	B	4	4.2	R or T
tungstic acid -------- powder $H_2WO_{4(s)}$	B	2	0	0	Causes eye irritation, harmful if swallowed or inhaled, chronic inhalation hazard.	D2, E	1	NR	WF/I or N/P-D

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
turpentine ---------- liquid $C_{10}H_{16(l)}$	B	2	3	0	Causes irritation to skin, eyes, digestive and respiratory tracts; harmful by ingestion, inhalation, or skin absorption; flammable liquid and vapours, flashpoint 35°C.	B, D2	5	3	WF/I
tyrosine(L & DL) -- crystals $C_9H_{11}NO_{3(s)}$	A	2	0	0	May cause irritation to skin, eyes, and respiratory tract; may be harmful if swallowed, inhaled, or absorbed through skin.	D2	8	NR	T
universal indicator–solution mixture: methyl alcohol --- 10 - 20% ethyl alcohol —- 60 - 100% methyl ethyl ketone- <0.5% ethyl acetate ----------<0.2% phenolphthalein ----- <1.0% methyl red ---------- <1.0% bromothymol Blue - <0.2% thymol blue ---------- <0.5% butter yellow -------- < 0.1% water ---------- balance	A	2	3	0	Causes irritation of the skin and respiratory tract, severe irritation of the eyes; may be fatal by excessive ingestion, inhalation, or skin absorption; flammable liquid.	B, D1	5	6.1	WF/I
urea ---------- powder (*carbamide)* $CH_4N_2O_{(s)}$	A	1	1	0	Causes irritation to skin, eyes, and respiratory tract; dust can be an explosive hazard if heated.	NC	8	NR	T or D (aq)
urethane -- crystals/powder (*carbamic acid, ethyl ester*) $C_3H_7NO_{2(s)}$	B	1	1	0	Causes irritation to skin, eyes, and respiratory tract; may cause irritation to digestive tract; solid and dust-air mixture combustible; possible human carcinogen.	NC	8	NR	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
valeric acid ---------- liquid (*n-pentanoic acid*) $C_5H_{10}O_{2(l)}$	B	2	1	0	Irritates the skin, causes severe eye and respiratory tract irritation and possible burns; ingestion may cause irritation with nausea, vomiting and possible burns; flammable if heated or ignited.	E	3	8	WF/I or N/P-T
L-valine ---------- crystals $C_5H_{11}NO_{2(s)}$	A	1	0	0	May cause irritation to skin and severe irritation to eyes, and respiratory tract.	NC	8	NR	T
vanadium ---------- powder $V_{(s)}$	B	2	1	0	Causes irritation to skin and respiratory tract, and severe irritation to eyes, may cause irritation to digestive tract.	D2	8	NR	R or T
vinegar ---------- solution (*acetic acid*) mixture: CH_3COOH --------- 5 - 7% H_2O ----------93 - 95% $CH_3COOH_{(aq)}$	A	1	0	0	Causes irritation of the nose, throat, and respiratory tract, prolonged contact may cause burns and dermatitis.	NC	1	NR	N/P-D
vinyl acetate ---------- liquid $C_4H_6O_{2(l)}$	C	1	3	1	Irritant to skin, eyes, and mucous membranes; highly flammable; possible human carcinogen.	B, D2	5	3	WF/I
vitamin C ---------- crystals (*ascorbic acid*) $C_6H_8O_{6(s)}$	A	1	1	0	May cause mild irritations of the skin, eyes, respiratory and digestive tracts; flammable if heated or ignited.	NC	3	NR	T or D (aq)
water glass --------- solution (*sodium silicate*) mixture: H_2O ----- 60 - 65% Na_2SiO_3–35 – 40% $Na_2SiO_{(aq)}$	B	2	0	0	Causes severe irritation to skin, eyes, and respiratory tract; harmful if swallowed or inhaled.	D2	8	NR	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
wintergreen oil ------- liquid (*methyl salicylate*) $C_8H_8O_{3(l)}$	A	2	1	0	Causes irritation of the skin, eyes, and respiratory tract; harmful if swallowed, inhaled or absorbed through skin; affects the kidneys and central nervous system.	D2	8	NR	WF/I
xylene (1, 2 & 1, 4 forms)---------- liquid (*dimethylbenzene*) $C_8H_{10(l)}$	C	2	3	0	Causes irritation of the skin, eyes, and respiratory tract; may be harmful if swallowed or inhaled; causes central nervous system depression; flammable liquid and vapour, vapour-air mixture explosive.	B, D1, D2	5	3	WF/I
zinc acetate --------- powder $ZnC_4H_6O_{4(s)}$	A	2	1	0	Causes irritation of the skin, eyes, and respiratory tract; harmful if swallowed or inhaled; combustible if heated or ignited.	D2	8	NR	WF/I or N/P-T
zinc carbonate ----- powder $ZnCO_{3(s)}$	A	2	0	0	May cause irritation to skin, eyes, and respiratory tract; may be harmful if swallowed, inhaled or absorbed through skin.	D2	8	9	WF/I or N/P-T
zinc chloride ------ granules $ZnCl_{2(s)}$	C	3	0	0	Corrosive; causes burns to any area of contact; harmful if swallowed or inhaled, extremely destructive to mucous membranes; affects the cardiovascular system.	D1, D2, E	8	8	WF/I or N/P-T
zinc metal--(mossy) chunks $Zn_{(s)}$	A	2	1	1	Dust may cause irritation to skin, eyes, and respiratory tract; harmful if swallowed or inhaled; dust-air mixture explosive, water reactive	D2	8	NR	R or T
zinc nitrate hexahydrate -------- crystals $Zn(NO_3)_2 \cdot 6H_2O_{(s)}$	A	2	0	2 ox	Causes irritation to skin, eyes, and respiratory tract; harmful if swallowed or inhaled; strong oxidizer, increases flammability of combustible substance in contact with it.	C, D1	6	5.1	WF/I

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Chemical Name (s), State and Formula	Use in School Category	H*	F*	R*	Hazards	WHMIS Class	Storage Class	TDG Hazard Class	Disposal
zinc oxide ---------- powder $ZnO_{(s)}$	A	1	1	0	May irritate the respiratory tract; dust-air mixture explosive.	NC	8	NR	T
zinc sulfate heptahydrate ------- crystals $ZnSO_4 \cdot 7H_2O_{(s)}$	A	2	0	0	Causes irritation to skin, eyes, and respiratory tract; harmful if swallowed, inhaled or absorbed through skin.	D2	8	NR	WF/I or N/P-T
zinc sulfide ---------- powder $ZnS_{(s)}$	A	1	0	1 W	Causes irritation to skin, eyes, and respiratory tract; harmful if swallowed or inhaled; contact with stomach acid produces toxic hydrogen sulfide; reacts with water to produce zinc sulfate.	D2	8	NR	T
zirconium ---------- chunks $Zr_{(s)}$	A	0	1	0	Metal non-toxic; combustible if heated	NC	8	4.1	R or WF/I
zirconium ---------- powder $Zr_{(s)}$	A	1	2	0	Causes some irritation to skin, eyes, and respiratory tract; ingestion causes severe irritation to mucous membranes; flammable	B, D1	4	4.1	WF/I

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Chapter 9
Chemical Management

OVERVIEW

Many chemicals can be managed safely by schools, as long as the hazards are known and appropriate precautions are taken. Chemicals designated as controlled, regulated or hazardous, however, require special attention through the full cycle of procurement, storage, use and disposal. Management of such chemicals requires a thorough understanding of their chemical properties, potential hazards, and what to do in case of an accident.

The focus of this chapter is on implementing a sound, comprehensive chemical management plan that addresses chemical purchasing, storage and inventory, as well as strategies for minimizing and managing chemical wastes. To ensure such a plan is working effectively requires auditing (and revising if necessary) processes for:

- ordering and receiving chemicals
- storing and handling chemicals
- disposing of chemicals.

CHEMICAL ACQUISITION

Choice of Chemicals

The selection of chemicals for use in school laboratories should be based on several considerations:

- curriculum needs
- value of the laboratory experiences provided to students
- chemical hazards
- likelihood of chemicals being used in multiple activities or classrooms
- maturity, knowledge and skills of the students
- availability of alternative activities and materials
- storage facilities and laboratory equipment available
- environmental considerations and costs related to disposal.

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In many cases, non-regulated chemicals that can be bought at the local store can adequately substitute for more hazardous chemicals called for in course activities. Choosing these household chemicals often reduces cost of purchase and disposal as well as the hazards associated with use. However, there are many chemicals required in science courses, particularly those in senior high school, that must be ordered from chemical supply houses. When choosing chemicals, consider whether the benefits outweigh the risks, and if they do not, look for safer substitutes.

If an activity that is being attempted for the first time calls for chemicals not on the shelf, schools may wish to borrow rather than purchase the chemicals, particularly if it is uncertain that these chemicals will be used again in the future. If borrowing requires transport between locations, TDG regulations must be observed.

Quantity Ordered

When determining how much of a specific chemical to order, consider the following factors:

- consumption rate
- stability of the chemical (most inorganic salts and dilute acids and bases stocked in schools do not deteriorate with time)
- future use of the chemical
- available storage space
- financial resources.

As a general rule, a "less is better" approach to chemical purchasing lowers inherent risks. Buying only what is needed, based on the factors above, also leads to better organization and less costly waste disposal at the end of the year. For less stable compounds, particularly those that decompose over time, keeping amounts ordered to a minimum will greatly reduce safety and storage concerns and disposal costs.

Suppliers sometimes sell large quantities of chemicals at considerable savings. Bulk purchase may be an option with frequently used chemicals, particularly those that are not considered hazardous or are not regulated. However, there are several reasons why such bulk orders may not be advisable.

- Adequate storage space may be limited.
- Curricular changes may occur or teachers may choose different experiments, eliminating the need for the chemical.
- Initial cost savings from bulk purchasing may be eliminated by added disposal costs if a large amount of the chemical is no longer needed and has to be disposed.

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Receiving Chemicals

Only TDG-trained (Transportation of Dangerous Goods-trained) personnel can receive incoming chemicals. Whenever an order of chemicals arrives, these individuals may follow the steps below or similar school or district procedures.

a. Check the integrity of each chemical and chemical container.
b. Check for WHMIS labelling and presence of MSDSs.
c. Write on each container the date received and the name of the school.
d. Enter information into a chemical inventory.
e. Store chemicals (apply colour-coding if that is the school's practice) and file paperwork.

STORAGE of CHEMICALS and household products

Storage of chemicals and other products requires thoughtful planning and appropriate facilities. Chemicals purchased from supply companies demand special attention with regard to safe storage. However, in addition to these chemicals, chemical storage areas in schools often contain consumer products, perishables, ice and frozen goods required by school science programs. Vitamins, antacids, detergents, yeast, soda drinks, vegetable oils, meats, dairy products, fruits, vegetables and baking goods are a few of the materials that may be found in school science areas.

Some of these products fit into a chemical storage category; others require additional storage space, often in a refrigerator or freezer. Consumer products classified as controlled products should be integrated into the storage scheme used for all other chemicals. According to Occupational Health and Safety regulations, materials for activities involving eating or tasting must not be used or stored in any areas used for hazardous chemicals, and, therefore, will also require an additional storage space outside of the chemical preparation and science laboratory areas. A refrigerator used for storing chemicals cannot be used for refrigeration of "eating" or "tasting" products.

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Storage Facilities for Chemicals

The hazards associated with chemical use can be greatly reduced by storing all chemicals in suitable storage facilities. An ideal chemical storage area:

- is a separate area outside of the classroom
- can be accessed only by authorized personnel
- has locking doors with a key separate from those used to enter classrooms or preparation areas
- is adequately vented with a continuously running fan to prevent build-up of chemical fumes
- protects chemicals from direct sunlight and extreme temperatures
- has explosion-proof lights, switches and fan motor housing to prevent fires caused by electrical shorts or sparks in faulty switches
- has ground fault interrupter (GFI) circuits installed, especially near sinks
- has ceilings and walls made of gypsum boards or a similar non-combustible material
- has adequate cupboard space for each category of chemicals, as determined by the quantity on-hand and school requirements
- has sturdy, non-metallic shelves that are securely fastened to the wall or are part of a securely fastened or supported cupboard
- has storage cupboards that are not airtight.

Flammables and concentrated acids may be stored in special cabinets purchased for these types of hazards. The issue of whether or not these cabinets should be vented and the method of venting depends on the purpose of the venting, for example, whether one is aiming to prevent the spread of a fire from flammable chemicals or to protect these chemicals from igniting if there is a fire in the room. On the other hand, if the air quality of the chemical storage area is a concern, then venting the cabinet to the outside is a practical option. Venting may be "gravity" driven or "forced air" (fan) driven. The method chosen will depend on the specific facility, its needs and other options for ensuring safe air quality in that particular storage area.

The chemical storage area(s) in a school should be large enough to house all of the chemical stock used in the science program as well as the waste chemicals generated through use. A typical senior high school of 800 to 1000 students will require a room with approximately 100 linear metres of shelf space. A junior high school may require 50 metres of shelf space. The space requirements should reflect the science programs offered, including waste generated by these programs throughout the year. Schools offering Advanced Placement or International Baccalaureate courses will require additional space. If a school is unable to accommodate its chemical stores in a facility

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similar to the one described in this section, this is an indication that the school may need to re-examine the amount of material they have in storage.

The chemical storage area should be equipped with appropriate safety equipment and supplies, including a first-aid kit. See Chapter 3 for more information.

Chemical Storage Schemes

In the past, chemicals have been stored using a non-classified system, with products placed on shelves in alphabetical order. Although this arrangement of chemicals appeared to be orderly, it resulted in highly reactive substances such as oxidizing agents and reducing agents being stored together, creating the risk of spontaneous reactions between incompatible chemicals. In some cases, flammable storage cabinets were used to store a variety of hazardous materials without consideration for their compatibility.

The risk of accidents can be greatly reduced by replacing this kind of non-classified storage system with a scheme that separates incompatible groups and isolates chemicals that present special hazards. The suggested storage schemes that follow can be used as a guideline for safe storage of chemicals in schools. By separating flammable solvents from reactive chemicals, and corrosive liquids from toxicants, these schemes eliminate the risk of spontaneous fire or release of poisonous fumes. These schemes are adaptable to facilities of various designs and to various chemical inventories. Schools may or may not have all of the hazard categories, and some schools may establish other categories to meet their particular needs.

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Scheme 1: Grades 1–8 (A storage scheme for limited quantities of low-hazard chemicals)

Scheme 1 provides for adequate separation of chemicals for most elementary and middle schools up to Grade 8 where small quantities of low-hazard chemicals and dilute solutions are kept on hand. This scheme could also be adapted for Grade 9, but is not adequate for senior high schools. Scheme 2 provides a better model for senior high school use.

Oxidizing Agents	**General**	**Flammable Solids**
Acids	**Bases**	**Flammable Liquids**

Scheme 1 is based on six cupboards but may be expanded to seven or more to provide sufficient space for general storage items. The shelves in these cupboards need to be secure and strong enough to support the weight of all containers placed on them. These cupboards must not be airtight.

In addition to the cupboards shown, a fridge may also be needed to store perishables and frozen products. If the refrigerator is used for storing materials for tasting or eating, it should be placed away from the chemical storage area and not be used for storing chemical and biological specimens. Further information on safe storage of chemicals is included in the storage category notes below.

1. *Acids*
   Keep organic acids (e.g., acetic acid) and mineral acids (e.g., hydrochloric acid and sulfuric acid) on separate shelves. The acid cupboard should not contain any metal fixtures or objects.

2. *Bases*
   This cupboard would shelve household ammonia, sodium hydroxide and other hydroxides. It should not contain any metal fixtures or objects.

3. *Oxidizing agents*
   Peroxides, bleach and nitrates are examples of oxidizing agents. Most peroxides are not recommended for elementary and junior

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high schools, but hydrogen peroxide would be shelved here. These materials must be kept away from any flammable liquids or solids, as well as materials such as paper or cloth. Ammonium nitrate, if purchased for use in junior high schools, should be stored by itself, as it is a very strong oxidizing agent and is incompatible with most other chemicals.

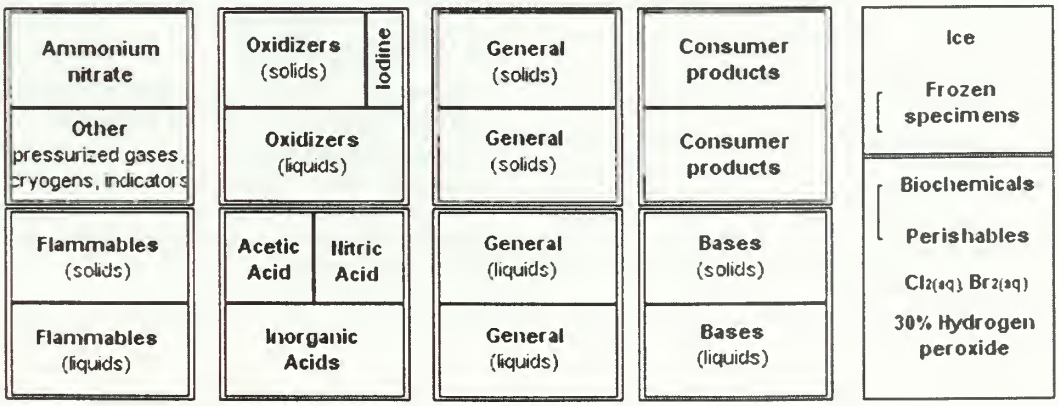
4. *Flammable solids*
   Flammable solids include metal powders, carbon, charcoal and similar materials. These materials must be kept away from oxidizing agents.

5. *Flammable liquids*
   Flammable liquids such as methanol and ethanol should be stored in a clearly labelled, cool and well-ventilated cupboard, separated from other cupboards by at least a partition. Refer to the *Alberta Fire Code* for regulations governing type, location, labelling, allowable quantities and other requirements for these storage areas. Avoid storing flammable liquids in a fridge, where lights, switches or thermostats can serve as ignition sources.

6. *General*
   This category includes any materials not covered in the other categories, such as Epsom salts, baking soda, starch, glycerin and vitamins.

Scheme 2: Grades 9–12 (A scheme for senior high schools)

Scheme 2 provides for adequate separation of chemicals in schools that offer science programs from grades 9–12. The scheme is based on a greater number of chemical categories than shown in scheme 1 and includes provision for refrigerated storage of some chemicals.



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Provide space between chemicals to facilitate access. Avoid storing chemicals more than three deep. If height of the cupboards requires the use of a stepladder or stool, it should have a non-slip surface.

1. Acids Store organic acids such as vinegar above or separated from mineral acids. Store acid anhydrides with this group. Nitric acid is a strong oxidizing agent and should be isolated as well. It will build pressure over time and should be vented periodically. Parafilm or plastic electrical tape can be placed around lids for storage, to help prevent the escape of fumes. Plastic lids will deteriorate with time and should be replaced when this occurs. This cupboard should not contain any metal fixtures or objects unless coated with special paint.	**2. Bases** **Store** any solid sodium hydroxide above or separated from dilute solutions of sodium hydroxide and household ammonia. Some bases will react with glass containers to form a filmy precipitate, and are best stored in base-resistant plastic bottles. Those that emit fumes should be sealed with parafilm or electrical tape. This cupboard should not contain any metal fixtures or objects.
3. Oxidizing agents Store nitrates, potassium permanganate and iodine solids above or separated from their oxidizing solutions. Lids on bottles of iodine should be sealed with parafilm or electrical tape. These materials must be kept away from any flammable liquids or solids and materials such as paper or cloth. **Ammonium nitrate** is an extremely strong oxidizing agent and is incompatible with most other chemicals. It should be stored away from other materials.	**4. General** Inorganics such as baking soda, salt and copper sulfate would be found here as well as organic compounds such as glucose, indicators and starch. This category includes any materials not in any of the other categories. Some further separation may be desirable if available storage facilities allow.
5. Flammable liquids Rubbing alcohol, ethanol, petroleum ether, and indicators dissolved in ethanol would be in this area. These materials should be stored in a clearly-labelled, cool and well-ventilated cupboard, separated from other cupboards by at least a partition. Ideally, flammables should be in a special cabinet manufactured for this purpose.	**6. Flammable solids** Flammable solids include metal powders, carbon, charcoal and similar materials. These materials must be kept away from oxidizing agents. Refer to the Alberta Fire Code for regulations governing type, location, labelling, allowable quantities and other requirements.

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Setting Up a Chemical Inventory

A chemical inventory is an effective way of tracking chemical supplies. It is also an excellent opportunity for schools to improve safety by recording and organizing information about hazardous materials in the school. Such an inventory is an important part of safety planning because it includes MSDS and TDG data, depends on standardized labelling, and encourages thoughtful ordering and disposal. A chemical inventory provides a consolidated information base for monitoring chemical usage, completing insurance claims, and coordinating waste disposal and recycling to reduce costs. It also allows for an integration of computer support systems and encourages sharing of information through computer networking. Finally, by establishing a system for monitoring chemical supplies on an ongoing basis, an inventory ensures program and support continuity when staff changes.

A computerized or electronic inventory is ideal because it is easy to update as chemicals come in or are removed from stock. The inventory can be stored centrally for easy access, with a copy supplied to the head caretaker and the individual(s) responsible for chemicals and hazardous materials in the school.

An effective chemical inventory will include the following information:

- name of chemical
- quantity of chemical
- supplier
- verification and date of MSDS
- date of purchase
- inventory review date
- hazard classification based on WHMIS requirements
- storage location
- disposal requirements.

For those choosing to track chemicals using a traditional paper-based inventory, a blank template of the sample inventory shown below is included as Appendix F of this document.

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Chemical Inventory – Example
Completed by _____ Review Date _____

Chemical	Quantity	Supplier	MSDS Mo/Yr	Purchase Date	WHMIS Class	Storage Location	Disposal	Disposal Date (Empties)
Acetic acid (glacial)	4 L	Chem North	Nov–03	Dec–03	E,B	Acid cabinet	WF/I	Feb–04
Ethanol	2 L	Chem North	Jan–03	Jan–03	B, D1,D2	Flammables cabinet	A,WF/I	March–04

Inventory Control

Inventories should be updated annually to reflect product use and curriculum changes. As chemicals are used or disposed of from the school site, they should be deleted from the inventory. An annual check of chemicals on the shelves is a chance to:

- remove chemicals unsuited for the program(s)
- remove excess supplies, including chemicals no longer used because of program changes or activities selected
- remove contaminated, deteriorated and unidentified chemicals
- ensure a current MSDS is available for each chemical (MSDSs are updated by supply companies every 3 years)
- ensure a WHMIS label is on every chemical container
- confirm chemicals are in their proper location on the storage shelf
- ensure that opened containers are being used before new stock is opened
- visually inspect chemicals on the shelf to ensure they have not deteriorated or been contaminated by moisture or other substances.

Labelling

Proper labelling is one of the most important aspects of an effective and safe laboratory. Labels alert the user to the hazards of the product and provide precautions for its safe use. Therefore, they must present the required information clearly and legibly.

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WHMIS Symbols and Labelling Conventions
Purchased stock chemicals kept in the storeroom, as well as materials that are generated in the laboratory for and by student experiments, require proper labelling according to WHMIS regulations. WHMIS requires increased information on labels of potentially hazardous materials, often referred to as "controlled products" in legislation.

In terms of labelling and MSDS requirements, the WHMIS definition of controlled product does not include radioactive materials, pesticides, explosives, consumer products or materials covered under Food and Drug legislation; a sufficient amount of information is provided to workers through other means to ensure the safe use of these products. Wood and tobacco products and manufactured articles are excluded from all aspects of WHMIS. Other provincial health and safety laws and regulations cover the hazards of these materials. WHMIS labelling uses the following symbols to indicate hazards:

WHMIS HAZARD SYMBOLS		
A	COMPRESSED GAS	
B	FLAMMABLE AND COMBUSTIBLE MATERIAL	
C	OXIDIZING MATERIAL	
D	POISONOUS AND INFECTIOUS MATERIAL	
D1	MATERIALS CAUSING IMMEDIATE AND SERIOUS TOXIC EFFECTS	
D2	MATERIALS CAUSING OTHER TOXIC EFFECTS	
D3	BIOHAZARDOUS INFECTIOUS MATERIAL	
E	CORROSIVE MATERIAL	
F	DANGEROUSLY REACTIVE MATERIAL	

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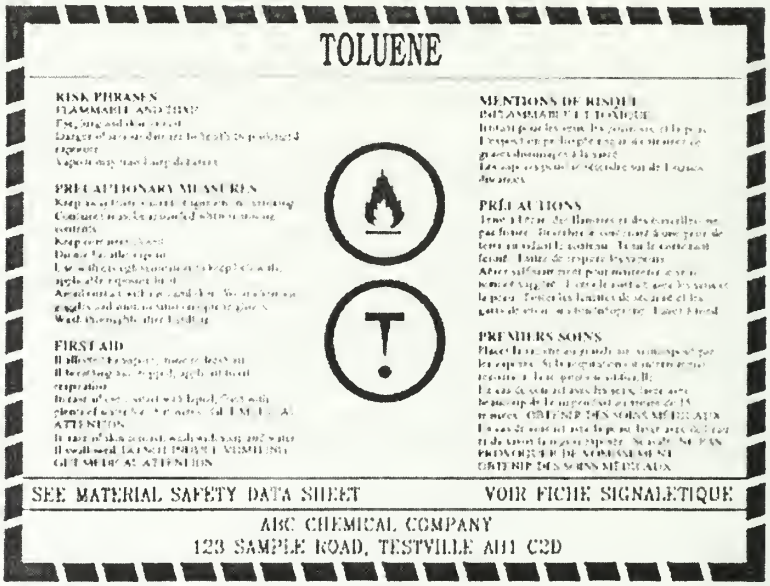
Supplier Labels

These labels come with the chemicals from the chemical supply company. The formal "supplier label" contains seven elements of information inside a distinctly marked border:

- product name and address of the supplier
- WHMIS hazard symbol(s)
- precautionary statements(s)
- first-aid information
- reference to the MSDS.

Example of a WHMIS supplier label:



(resized)

All chemical containers, including the original container, must be labelled in such a way as to clearly identify the contents. There are a few situations where the supplier label may be slightly different from the basic model. This may be the case for controlled products in volumes less than 100 mL and for compressed gas cylinders having curved labels on their necks.

Workplace Labels

These labels are applied at the worksite. They are used on controlled products that are transferred from the supplier's containers to worksite containers. In the laboratory, for example, transfer containers and reaction vessels containing mixtures, solutions or reaction products must have a workplace label. Workplace labels are also used to replace supplier labels that have been damaged.

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This form of label has four components as shown below:

Chemical Name (IUPAC):
Chemical Name (from MSDS):
Safe Handling Information (in point form):
See *Material Safety Data Sheet* for further information.

TDG Labels

During transport, controlled goods must be labelled using the specific guidelines given in the *Transportation of Dangerous Goods Act and Regulations*. Transporting vehicles are also required to display diamond-shaped placards that indicate the hazard categories of materials being transported. (See Chapter 1 for further information on TDG requirements.)

Consumer Restricted Products and Other Hazardous Materials

Other legislation in Canada requires precautionary labelling on containers of hazardous materials not covered under WHMIS, such as consumer restricted products, explosives, pesticides or radioactive substances. Consumer restricted products are hazardous chemicals that are packaged for consumer use at home or for recreational purposes. Such products include bleach, hydrogen peroxide, mineral spirits, drain cleaners and turpentine. These are not regulated as closely as controlled products; and accordingly the supplier does not need to supply an MSDS with these products, but will nevertheless provide them on request. As with other consumer products, they have to be clearly labelled and indicate any hazards inherent in the product. When used in the workplace these products are subject to WHMIS regulations, which require that:

- they are correctly labelled
- workers know how to use, store, handle and dispose of them safely.

In some jurisdictions, liability suits have identified lack of proper labelling as a contributing cause of an accident. Careful labelling practices help prevent accidents and protect the teacher and school division/district from assuming unnecessary liability.

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CHAPTER 9

WASTE STORAGE and DISPOSAL

Storage of Wastes and Surplus Chemicals

Surplus chemicals and chemical wastes created in experiments present the same kinds of hazards as stock chemicals ordered from supply companies. Chemical waste from individual experiments should be collected in clearly labelled containers. With solutions, the water can be allowed to evaporate to leave a solid waste residue. Until each surplus chemical or waste material can be safely removed, it should be carefully stored in the cupboard normally used for that WHMIS classification. Proper waste storage includes:

- attaching appropriate identification and WHMIS labels
- categorizing and arranging waste by WHMIS class
- using a separate section or sections of the storage area, designated with a label stating "For disposal. Do not use!"
- avoiding physical contact between waste groups when wastes are stored
- keeping an inventory of waste materials.

Chemical wastes should be combined for storage according to the categories used by disposal companies. Common categories are shown in the table below, but it would be prudent to consult with your school's selected waste disposal company before beginning your sorting system.

Flammable	– liquids	
	– solids	
Corrosive	– liquids	– acids
		– bases
	– solids	– acids
		– bases
Oxidizers	– liquids	
	– solids	
Substances that react with water emitting flammable gas		
Unknown chemical waste		– liquid
		– solid
Waste mercury compounds		– liquid
Waste containing polychlorinated biphenols		
Waste aerosols		
Waste bulk paint		
Waste type 201 (oil)		
Waste type 202 (glycol)		

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Chemical Waste Inventory

Waste disposal records are the last stage in tracking a chemical's history at the school. These records are essential because:

- they are needed to keep the chemical inventory up-to-date, and to remove unnecessary labels and MSDS in cases where the chemical is no longer stocked
- shipping documents for chemical wastes (bills of lading for recyclables and manifests for hazardous waste) must be kept on file for a minimum of two years
- hazardous waste manifests can be useful in tracking and evaluating amounts of waste produced to help determine possible methods of reducing waste/surplus chemicals in the school or school district.

Disposal of Wastes and Surplus Chemicals

Most often, chemical wastes are the result of reactions that produce a hazardous or regulated product or mixtures of products that cannot be separated easily. Generally, such waste materials will have to be sent to a chemical waste facility. It is the school's responsibility to ensure that proper procedures are in place to deal with transport and disposal of surplus chemicals and hazardous waste materials. The best way to ensure that this is manageable is to allocate funds for proper disposal at the time when chemicals are purchased. Disposal procedures must follow requirements laid out in federal and provincial legislation (including the Waste Control Regulation of the *Alberta Environment Protection and Enhancement Act,*: Alberta Regulation 192/96), as well as local or municipal regulations, by-laws or policies regarding sewers, landfills and the environment.

To avoid safety risks, particularly with more volatile or less stable compounds, monitor shelf life of the surplus chemicals to prevent prolonged periods in storage (i.e., more than 3 years). Look for and dispose of old chemicals. For example, old containers of dissection preservative containing formaldehyde can often be overlooked for years. The fumes from such containers can combine with those of hydrochloric acid to form bischloromethyl ether, a strong carcinogen at concentrations as low as 0.001 ppm.

Conducting a chemical inventory can help you identify and dispose of unneeded or dangerous chemicals such as the following:

- any chemicals that have deteriorated or become contaminated
- chemicals not utilized in current teaching lessons and unlikely to be used in the future
- chemicals for which MSDSs are not available

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- any seldom-used chemical in excess amounts (several containers of the same chemical or unnecessarily large bulk quantities)
- unknown chemicals or chemicals without a WHMIS label
- chemicals that have exceeded their shelf life
- old solutions of formaldehyde or other dissection material preservatives.

Appropriate planning and procedures are required to safely dispose of all hazardous or regulated surplus chemicals as well as hazardous wastes. The following materials require special disposal procedures.

- Substances that are designated as hazardous (regulated) within the *Transportation of Dangerous Goods Act*.
- All hazardous wastes, if the school produces a total of 5 kg or more of solid or 5 L or more of liquid hazardous wastes per month.
- Any containers of unknown substances.

Waste Broker and Waste Generator Identification Number

The three categories of materials listed above must be removed from the school by a licensed waste broker and disposed of by a licensed receiver. A *broker* is a company licensed by the province to pick up and transport controlled substances to a *receiver*, a licensed waste disposal facility. Disposal of waste from a school must be initiated through the school district office and the contract for removal will be between the district and the broker.

School districts may want to investigate a number of brokers in order to select one that best meets their particular needs. For a list of approved brokers, see Appendix G: List of Chemical Waste Brokers. Alternatively, to find a broker in their area, districts may contact the Regulatory Approvals Centre of Alberta Environment:
Telephone: 780–427–6311, or Fax: 780–422–0154.

Before hazardous waste can be disposed of, school districts are required by the *Alberta Environmental Protection and Enhancement Act* to obtain a provincial **waste generator identification number**, which must be provided to their waste broker. To obtain an identification number, districts may contact the Science and Standards Branch of Alberta Environment:
Telephone: 780–427–0606.

Ecostations and sites designed for drop-off and disposal of household wastes are not appropriate for disposal of school chemical wastes.

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Waste Management and Environmental Responsibility

Proper storage and disposal of surplus chemicals and hazardous waste is not only part of science safety, but also an environmental issue. By being environmentally conscious in the day-to-day management of school laboratories and materials, teachers and other school personnel can prevent unnecessary damage to the environment and instill responsible attitudes in students.

Chemical disposal regulations prevent indiscriminate dumping of chemical waste in the trash or down the drain where to do so would create environmental risks. Landfills, once thought of as the dumping place for all manner of materials, are now designated by classes based on their design. These class designations indicate the scope of wastes that a landfill of that design can safely accept . Municipal authorities can provide information on the class of local landfills and the types of chemicals that can be disposed of through regular trash. Similarly local sewer by-laws identify restrictions on materials that can be disposed via the drain.

The disposal column of the Chemical Hazard Information Table in Chapter 8 and the Chemical Treatment section in this chapter provide basic information on what chemicals can be disposed of via the drain or trash, and what treatment may be required before this can be done. For all other chemicals, it is best to strive for a "no chemicals down the drain" philosophy, whereby chemical waste is disposed of by an alternative means that avoids environmental impact. This approach to waste management may require that students and/or teachers place chemical wastes into labelled waste containers on completion of their use. Teacher caution in categorizing waste is needed to avoid placement of incompatible waste together. The waste is then managed in accordance with accepted best practices. In larger schools, the pooling of wastes for disposal though a waste broker may be the best strategy for ensuring safe disposal of many hazardous materials.

Strategies for Minimizing Hazardous Waste Production

There are several straightforward and practical ways to reduce the volume of chemical waste generated by science classes. Most of the strategies discussed here involve students using less chemicals, which results in less waste generated, less environmental impact and lower waste disposal costs. Other strategies suggest ways to recover chemicals for reuse or to make multiple use of the chemical.

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Microscale Experiments

Traditional practice in school laboratories is for students to perform experiments using gram quantities of chemicals. An alternate approach is to have students carry out "microscale" experiments in which chemical quantities are reduced to no more than 100 mg (0.1 g). Chemical experiments are equally successful using considerably smaller quantities of materials, and many students enjoy the challenge of performing experiments on a miniature scale.

Microscale experiments may require the use of different glassware and equipment or the use of existing equipment in new ways. Instead of beakers and Erlenmeyer flasks, teachers may use small test tubes or drop plates. Disposable pipettes calibrated to allow delivery of 0.5 mL or 1 mL can be used to deliver chemical solutions. Reaction plates with a series of wells can be used in performing qualitative analysis of inorganic ions. Disposable pipettes in which the stem has been cut short and a small wad of glass wool inserted can be substituted for filter funnels to collect a few crystals by filtration.

When students are planning an experiment to investigate a particular concept, they can be encouraged to think about using smaller volumes. Although not strictly 'microscale', experiments using quantities between 0.1 and 1 gram are often very practical.

Dispensing Chemicals

It is sometimes necessary to strike a balance between dispensing pre-measured quantities of chemicals to students and teaching students to measure amounts for themselves. This decision depends largely on the hazards associated with the chemical. If it is a chemical that is non-toxic and non-hazardous, like sodium carbonate, then waste generated by students during measuring is not a major concern. If, on the other hand, the substance is magnesium ribbon, it may be preferable to pre-cut the appropriate length of ribbon for each student to avoid pieces longer than necessary. Pre-measurement may also help to minimize waste and the possibility of spillage when more hazardous solutions are used.

Use of Lab Stations

Setting up activities at specific sites or stations, equipped with appropriate chemicals and supplies, makes it easier to control and manage use of chemicals by students. This practice avoids students jostling for materials on carts or tables, hence reducing the chance of spills or other accidents. Where solutions or powdered chemicals can be repeatedly reused by each group of students, these could be

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provided at the station, thus minimizing waste production. In activities where probes are used for specific measurements or readings, solutions provided at a station could be used repeatedly as each group progresses through the station. Since students also leave everything behind once they are done at each station, there is less likelihood of chemicals being intentionally mixed by students out of curiosity. This reduces the generation of unknown and unnecessary wastes that are costly to identify and dispose of via chemical treatment plants.

Use of Demonstrations

Although there is obvious educational value in having students perform experiments on their own, demonstrating a chemical reaction to an entire class can be an effective means of achieving an instructional goal and reducing resulting wastes, particularly in cases where the chemicals involved are more hazardous.

Use of Videos and Computer Simulations

These resources can be used to demonstrate reactions or experiments that otherwise would not be possible due to equipment limitations or because they are too dangerous to perform in class. Such visual presentations or simulations of more dangerous reactions avoids associated risks and provides a near first-hand experience for students. These resources can be used either as part of a class presentation or individually, at stations, by students.

Recovery and Recycling

One aspect of good chemical management is to recycle materials whenever possible. Before discarding uncontaminated chemicals or their solutions, consider other activities where these substances may be required. For example, copper sulfate solution produced when teaching students how to make solutions can be used for growing crystals, copper plating or in replacement reactions in the same or other courses. Similarly, crystals grown in one class may be re-dissolved for use in another because these solutions do not require great purity.

Chemical recovery requires some upfront planning and a space in the lab or chemical storage room where reconstitution can be done. Since most substances used are in solution form, reclaiming the material simply requires evaporating the water. If a recovered substance is stored in a container other than the original, then proper WHMIS labelling is required on the new container.

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Distillation of Used Solvents

Recycling solvents requires the knowledge and experience of an expert chemist, as well as the appropriate equipment. Organic solvents such as methanol, ethanol and petroleum ether used in a reaction or as a solvent in chromatography can often be recovered for reuse by distillation. If possible, the distillation apparatus should be set up in a fume hood. The flask should be heated using a water bath (for low boiling solvents such as methanol and petroleum ether), oil bath or heating mantle. The contents of the distilling flask should never be allowed to evaporate to dryness.

Hazardous Waste Treatment

There are several methods of processing hazardous waste to reduce volume and/or toxicity in preparation for disposal. These processes can reduce disposal costs and environmental impact, especially for larger quantities. Since schools may still have chemicals on site that are no longer used or are not recommended for use in schools—for example, heavy metals such as lead—treatment processes for these substances have been included. Their inclusion, however, does not imply appropriateness for school use. Hazardous waste treatment includes evaporation of aqueous solutions and various chemical treatments.

Evaporation of Aqueous Solutions

When solutions contain chemicals not suitable for recovery, the volume of hazardous materials can be greatly reduced by allowing the solution to evaporate in a fume hood or other well-ventilated area. Transfer the solution to a wide-mouthed container such as an evaporating basin or large beaker for maximum evaporation surface and allow to stand until a sludge remains. This sludge can be transferred to an appropriate labelled container for off-site disposal.

There may be cases where regulations restrict disposal down the drain but allow disposal via local landfill. In such cases, evaporate to dryness and dispose in solid trash.

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Chemical Treatment

A number of substances can be chemically converted into an insoluble or less toxic form that may, in many cases, be disposed of by means other than a chemical waste facility. Appropriate personal protective equipment, including eye protection, gloves and laboratory coat, should be worn when performing the reactions. As far as possible, and in all cases where noted, the manipulations should be performed in a fume hood.

These chemical treatments should only be carried out by staff who have knowledge of the chemistry involved, and are experienced in working with chemicals. In all other cases, the chemicals—in their original form—should be disposed of through a qualified waste broker.

Neutralization of Acids and Bases

Waste quantities of acids such as hydrochloric acid, sulfuric acid, nitric acid and acetic acid, and bases such as sodium and potassium hydroxides can be neutralized and washed into the drain. First, add the concentrated acids or bases to 20 times their volume of water so that their concentration is reduced below 5%. This should be done in an ice bath in a fume hood using an adequately-sized container (100 mL of concentrated waste will require 2 L of water). Caution: never add water to concentrated acid. Add 5% sodium hydroxide solution or solid sodium carbonate (soda ash) to the dilute solutions of waste acid until the pH is between 6 and 8. Waste dilute solutions of base can be treated with waste dilute solutions of acid or with 5% hydrochloric acid solutions. The neutralized solutions can be washed down the drain.

Precipitation of Heavy Metal Salts

Although heavy metals are not recommended for school use, the process described here is for the benefit of schools that may still have these compounds on their shelves and are looking at discarding them. An alternative to the evaporation of dilute aqueous solutions of heavy metal salts is to precipitate the metals as an insoluble salt that can be removed by filtration or by allowing the solid to settle and decanting the liquid. The residue can then be disposed of according to relevant guidelines. Specific directions for precipitating lead ions from solution as their silicate is described as well as the modifications needed to use this method for other heavy metal ions. The formation of the silicate can be summarized by the following generalized equation.

$$Pb^{2+}(\ )_{(aq)} + Na_2SiO_{3(aq)} \rightarrow PbSiO_{3\,(s)} + 2Na(\ )_{(aq)}$$

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Add a 0.01 molar solution of a soluble lead salt (e.g., 0.166 g of lead II nitrate in 50 mL of water) to a 0.03 molar solution of sodium metasilicate (0.392g $Na_2SiO_3 \cdot 9H_2O$ in 50mL of water). Stir well. Adjust the pH to about 7 by the addition of about 15 mL of 2 M aqueous sulfuric acid. Collect the precipitate by filtration or allow the mixture to stand until the solid has settled to the bottom of the container and the liquid can be poured off. Allow the solid to dry, then package and label for disposal.

For dilute solutions of lead salts of unknown concentration, the sodium metasilicate solution should be added until there is no further precipitation. Adjust the pH to a level between 7 and 8 with the addition of 2M sulfuric acid, and allow the solution to stand overnight before collecting the solid by filtration or allowing it to settle and pouring off the liquid. Solutions of cadmium and antimony salts can be treated similarly.

Several other heavy metal salts can also be precipitated in the same way as silicates. The quantities given for lead are also appropriate for 0.01 moles of these metals. The only modification necessary is a change in the pH at which the silicate is precipitated. This includes the Fe (II) & (III) ions, Zn(II) , Al(III), Cu (II), Ni (II), Mn (II) and Co (II) ions, all of which can be precipitated without adjustment of the pH that results from the addition of the solutions of sodium metasilicate.

pH of Precipitation of Metal Ions Using Sodium Silicate

Metal Ion	pH for Maximum Precipitation	Concentration of Metal Ion Remaining in Solution
Iron II	9.5 – 10.0	5 pmm
Iron III	10.0 – 10.5	2 ppm
Zinc II	8.5	< 0.5 ppm
Aluminium III	8.5	< 2 pmm
Copper II	10.5 – 11.0	0.03 ppm
Cobalt II	9.5 – 10.0	0.08 ppm
Manganese II	9.5 – 10.0	0.2 pmm
Nickel II	9.5 – 10.0	0.3 pmm

Similarly, solutions of unknown concentration can be treated with sodium metasilicate solution until there is no further precipitation. Adjust the pH to the required value by the addition of 2 M sulfuric acid or 5% sodium hydroxide solution and allow the mixture to stand overnight before collecting the solid by filtration or allowing it to settle and pouring off the liquid. After standing in the air to dry, the metal silicates should be placed in a labelled container for disposal. The liquids can be washed into the drain.

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Reduction of Oxidizing Agents
Inclusion of this reduction process does not imply appropriateness for school use of some of the compounds identified here. The process is described, however, for the benefit of schools that may have these compounds on their shelves and are looking at discarding them.

Solutions of compounds such as potassium permanganate, sodium chlorate, sodium periodate and sodium persulfate should be reduced before being discarded into the drain to avoid uncontrolled reactions in the sewer system. The reduction can be accomplished by treatment with a freshly prepared 10% aqueous solution of sodium bisulfite or metabisulfite. Specific quantities and conditions for these reactions are detailed in the table below.

Oxidizing Agent Present in Waste Stream	Quantity and Concentration of Oxidizing Agent in Aqueous Solution	Quantity of 10% Aqueous Sodium Metabisulfite	Comments
Potassium Permanganate	2 L of 6%	1.3 L	Solution becomes colourless
Sodium Chlorate	1 L of 10%	1.8 L	50% Excess reducing agent added
Sodium Periodate	1 L of 9.5%	1.7 L	Solution becomes pale yellow
Sodium Persulfate	1 L of 10%	0.5 L	10% excess reducing agent added

Treatment of Iodine and Iodine Solutions
In the fume hood, cautiously add 1 gram of solid iodine to a solution of sodium thiosulfate (2.5 g sodium thiosulfate in 60 mL of water) also containing 0.1g of sodium carbonate. Stir the mixture until the iodine has all dissolved and the solution is colourless. Check the pH and if needed add solid sodium carbonate to bring the pH of the solution to a level between 6 and 8. The solution can then be washed into the drain. A summary of the reaction is:

$I_{2\,(s)} + Na_2S_2O_{3(aq)} + Na_2CO_{3\,(aq)} \rightarrow 2NaI_{\,(aq)} + Na_2SO_{4(aq)} + S_{(s)} + CO_{2\,(g)}$

Solutions of iodine can be dealt with as follows: Stir a sodium thiosulfate solution (4 g in 100 mL of water) containing sodium carbonate (0.1 g) into the iodine solution. Continue stirring until the solution becomes colourless. If necessary, add sodium carbonate to bring the pH to a level between 6 and 8. Treat the liquid for sulfides.

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Bromine

Bromine is very toxic by inhalation and causes severe burns if spilled on the skin. It can be reduced to sodium bromide, a much more innocuous substance, by reaction with sodium bisulfite solution.
In the fume hood, add bromine (5mL) to a large excess of water (1L). Slowly add a freshly prepared 10% solution of sodium bisulfite to the bromine water until all colour disappears. Neutralize the solution with sodium carbonate and wash into the drain.

$Br_{2(l)} + 2\ NaHSO_{3\ (aq)} \dashrightarrow 2NaBr_{(aq)} + H_2SO_{4(aq)} + SO_{2(g)}$

Treatment of Sulfides

In a fumehood, place 1 mol/L $FeCl_3$ solution (3 times the excess of solution to be disposed of) in a beaker, then add disposal solution with continuous stirring. A precipitate will form. Neutralize with sodium carbonate, a reaction that will release CO_2 gas.

A summary of the reaction can be given as follows:
$2\ Fe^{+++} + 3\ S^{-} \rightarrow FeS_{3\ (s)}$

Allow precipitate to settle and either decant solution or filter. Flush neutral solution down the drain and dispose of the precipitate to an appropriate landfill. If flushing of iron is a sewer concern, then all the material may be evaporated to dryness and disposed of via solid waste disposal.

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Appendix A

Science Safety Rules and Procedures

For secondary science students (not a conclusive list):

1. Read all directions before starting an experiment.
2. Behave responsibly in the science laboratory at all times.
3. Know the location and purpose of safety equipment.
4. Always alert the teacher immediately if any accident occurs.
5. If you wear contact lenses, notify the teacher. Some activities may require you to remove contact lenses.
6. When instructed, wear safety goggles and protective clothing.
7. Wear closed shoes during laboratory sessions.
8. Keep your hair tied back if it is long.
9. Do not use cracked or chipped laboratory glassware.
10. Use chemicals in the lab only.
11. Take only as much chemical as needed and never return excess chemicals to the original container.
12. Dispose of chemicals as directed by your teacher.
13. Hold bottles by the base, not by the neck.
14. Do not taste anything unless you are instructed to do so.
15. Never eat or drink in the science classroom.
16. Never enter the chemical storeroom without permission.
17. Always clean off bench and sink after an experiment.
18. Wash your hands thoroughly with warm water and soap at the end of the activity or the laboratory session.

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Appendix B

Sample Student Safety Contract/Agreement – Elementary

Class: _____ Student's Name: _____

Teacher's Name: _____

Room: _____

I am learning to be a good scientist. I know that to learn science safely I must be neat, organized and responsible.

I promise to:

- be prepared for science activities
- listen to directions and make sure that I understand them before I start
- follow directions
- do each step in order and not try other things
- observe carefully
- be calm and quiet so that I can learn more
- write down what happens during science activities
- handle equipment carefully and put it away when I am done
- wash and return all things to their proper place, then wash my workspace and my hands
- follow all safety rules.

I will do all these things to be a good investigator at school.

Student (signature): _____ Date: _____

Parent (signature): _____ Date: _____

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Appendix C

Sample Student Safety Contract/Agreement – Secondary

Class: _____ Student's Name: _____

Teacher's Name: _____

I will:

- Follow all written and oral instructions given by the teacher.
- Ask any questions or state any concerns I have before beginning a lab procedure.
- Behave in a manner that will ensure the health and safety of myself and others in the laboratory or classroom at all times.
- Use protective devices for my eyes, face, hands, body and clothing during laboratory activities.
- Know the location and use of first aid and fire extinguishing equipment.
- Refrain from eating, drinking, chewing gum or applying cosmetics in the laboratory.
- Keep my work area clean and free of clutter during lab class.

I understand and realize that many accidents are caused by carelessness and being in a hurry. I will come to class prepared to be responsible so that the safety and welfare of myself and others is not jeopardized.

I have read the written science safety rules prepared by my teacher and agree to follow these and any other rules.

Student's signature_____Date: _____

Parent's signature_____ Date: _____

Teacher's signature_____ Date: _____

Please list any known allergies or health problems that may affect participation in science activities (if additional space is needed, please use the back of this sheet.):

_____

Do you wear contact lenses: ❑ YES ❑ NO

Contact lenses are not recommended to be worn in the laboratory as chemical fumes or small particles may become lodged under the lens. There is a slight increase in the risk of eye damage for contact lens wearers compared to students in similar situations without contact lenses. All students must wear safety goggles for certain activities, even if they wear contact lenses or prescription glasses.

Please check the appropriate choice below and sign. Whatever your decision, it is up to your son/daughter to follow your choice.

1. My son/daughter will wear contact lenses under goggles during labs._____
2. My son/daughter will remove contact lenses prior to lab and will wear glasses under goggles____

Parent/Guardian Signature: _____ Date: _____

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Appendix D

Chemical Laboratory Safety Inspection Checklist

Inspect By: _____ Date: _____

Building and Room: _____

A. Documentation	Yes	No	N/A	Comments
Science safety rules and procedures are posted?				
Emergency procedures are posted?				
Chemical spill response guidelines are available?				
Chemical inventory is available and up to date?				
MSDSs are available for all controlled products?				
WHMIS and other training records available?				

B. Housekeeping

Benches and sinks are clean and tidy?				
Exit doors are unobstructed?				
Aisles are unobstructed?				
No tripping hazards are present (e.g. cords, hoses, equipment)?				
Separate disposal bin is available for broken glass?				
No food or drink is present in the laboratory?				

C. Emergency and Safety Equipment

Appropriate fire extinguisher(s) is available?				
First-aid kit is accessible and fully stocked?				
Safety glasses are available and in use?				
Lab coats and gloves are available and properly used?				
Eyewash is available and accessible?				
Emergency shower is available and accessible?				
Spill kit accessible and fully stocked?				

D. Chemical Storage

All chemicals have WHMIS compliant labels?				
Chemicals are segregated by compatibility class?				
Chemicals are dated upon receipt?				
Peroxides are labelled with container opening date?				
All gas cylinders are upright and secured in cool storage?				
Chemical waste is properly stored and labelled?				

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Appendix E

Accident/Incident Report Form

Part A – To be completed by individual(s) directly involved or injured in the incident.

☐ Medical Aid ☐ Lost Time ☐ Spill/Contamination/Environmental Release
☐ Near Miss ☐ Property Damage

IDENTIFY – Person(s) involved

Date and time of Incident

_____ / ____ / _____ _____ AM / PM

First Name Last Name YR MO DD HH:min

☐ School Nurse
☐ Hospital
☐ Clinic or Family Physician

Date and Time of **Medical Evaluation**: ____ / ____ / ____ / _____

YR MO DD HH:mm

Exact details of injury/illness and treatment (e.g., body part involved, cut, strain, bruise, illness symptoms and date of onset, etc.)

_____

_____

W.C.B. Form: (Please check) ☐ Has been prepared and forwarded ☐ Not required

Description of Incident (Add additional pages if necessary)
State exactly the sequence of events leading to the incident, where it occurred, what the person was doing, the size, weight and type of equipment or materials involved, etc.

_____

_____

_____

WITNESSES (If any)

Name	Department	Telephone No.

PROPERTY DAMAGE

Identify property involved	Description of damage or loss	Estimated value of loss

Completed by: _____ Date: _____

Print Name

_____

Signature

Forward to supervisor immediately.

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PART B – To be completed by supervisor within 24 hours.

Why did it happen? (conditions and/or actions contributing to injury/incident).

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Corrective Actions to Prevent Re-occurrence	**Action by whom and Date to be completed**

Investigated by: _____ Title: _____

_____ Telephone No.: _____ Date: _____

Signature

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Appendix F

Chemical Inventory

Chemical Inventory

Review date _____

Chemical	Quantity	Supplier	MSDS Mo/Yr	Purchase date(s)	Storage location	Disposal

Appendix G

List of Chemical Waste Brokers

Alberta Facilities with an Environmental Protection and Enhancement Act Approval to Manage Hazardous Waste/Hazardous Recyclables – 12 September, 2003

Approval ID	Company Name	Location	Telephone No.	Type of Operation
71724	652395 Alberta Ltd. (L & P Disposals)	High Level	780–926–2988	High Level Used Oil Recycling Facility
10522	Astra Battery Recycling Inc.	Wetaskiwin	780–352–6477	Wetaskiwin Battery Recycling
140712	BK Oilfield Disposal Ltd.	Sexsmith	780–538–1338	Sexsmith Waste Storage Facility
19712	Bearspaw Carbon	Crossfield	403–946–4655	Crossfield Hazardous Waste and Hazardous Recyclables
48516	Byram Industrial Services Ltd.	Drayton Valley	780–542–4733	Pembina Hazardous Waste Landfill
11366	Canadian Oil Recycle Corp.	Spirit River	780–864–2140	Spirit River Used Oil Storage and Transfer Facility
11442	CCR Technologies Ltd.	Brooks	403–543–6699	Brooks Solvent Recycling
1821	Ceda Reactor Ltd.	Edmonton	780–944–0035	Edmonton Waste Management
20304	CFR Chemicals Inc.	Red Deer	403–346–2214	Red Deer Hazardous Recycling Storage
49829	City of Edmonton	Edmonton	780–496–5414	City of Edmonton ECO Station
10348	Clean Harbors Canada, Inc.	Ryley	780–663–3828	Ryley Hazardous Waste Landfill
233	Criterion Catalysts and Tech.	Medicine Hat	403–528–8390	Medicine Hat Catalyst Regeneration and Manufacturing Plant
134	Custom Environmental	Edmonton	403–440–1825	Elmjay Industrial Park Hazardous Waste Storage
83252	Custom Industrial Cleaners	Drayton Valley	780–542–2462	Drayton Valley Used Oil Storage and Recycling Facility
10195	DBS Environmental	Lethbridge	403–328–4833	Lethbridge Hazardous Waste Storage
1744	Earth Tech (Canada) Inc.	Swan Hills	780–333–4197	Alberta Special Waste Treatment Centre
9758	ECL Environmental Services Ltd.	Calgary	403–720–1039	Calgary Hazardous Waste Recycling Storage and Transfer
167152	Eco-Max Inc.	Slave Lake	780–849–5549	Slave Lake Hazardous Waste Recyclable Storage Facility
522	EILEnvironmental	Onoway	780–448–0866	Onoway Hazardous Waste Storage and Transfer
9963	EnviroSORT Inc.	Red Deer	403–342–7823	Red Deer (Blindman Industrial Park) Hazardous Waste
70990	EnviroSORT Inc.	Grande Prairie	780–532–7384	Grande Prairie Hazardous Recyclable Storage Facility
77465	Enviro Waste Management Services Ltd.	Peace River	780–624–4613	Peace River Hazardous Waste Storage and Recyclable Fac.
183662	General Recycling Industries Ltd.	Edmonton	780–461–5555	Edmonton Battery Storage Facility
71259	Great Western Containers Inc.	Edmonton	780–440–2222	Edmonton South Container Reconditioning Facility
72803	Great Western Containers Inc.	Calgary	403–279–2191	Calgary Hazardous Waste (Drum Reconditioning) Plant
49861	Hazco Environmental Services Ltd.	Beaverlodge	780–354–3279	Beaverlodge Waste Storage and Transfer
10050	Hazco Environmental Services Ltd.	Calgary	403–297–0444	Calgary Waste Storage and Transfer
9790	Hub Oil Company	Calgary	403–273–2515	Calgary Used Oil Recycling Plant
1559	Jasper National Park	Jasper	780–852–6170	Jasper Hazardous Waste Storage

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Appendix G (continued)

Approval ID	Company Name	Location	Telephone No.	Type of Operation
69000	Little Dipper Holding Ltd.	Lloydminster	888–333–0657	Lloydminster Hazardous Recyclable Storage/Processing
132	Maple Leaf Metal Industries Ltd.	Edmonton	780–468–3951	Edmonton Metal Processing
11640	Maratek Environmental Services Ltd.	Edmonton	780–496–9678	Edmonton Hazardous Recyclable Processing Plant
9729	Newalta Corporation	Airdrie	403–948–1360	Airdrie Shurtleff Oil Processing
149	Newalta Corporation, Edm. Processing	Edmonton	780–440–6780	Edmonton Fuel Blending and Used Oil Processing
101	Newalta Corporation, Edm Tank Farm	Edmonton	780–440–6780	Strathcona Hazardous Recyclable
119	Newalta Corporation	Grande Prairie	780–469–2324	Grande Prairie Used Oil and Waste Plant
9774	Newalta Corporation	Lacombe	403–948–1360	Lacombe Bunker Fuel Blending Plant
9716	Newalta Corporation	Redwater	780–942–2240	Redwater Sludge Dewatering
1505	Newalta Corporation , Ray. Processing	Raymond	403–752–3213	Raymond Solvent Recycling and Fuel Blending
1459	Newalta Corporation, Ray. Tnkfrm	Raymond	403–752–3213	Oil & Waste Solvent Collection and Storage
1399	Newalta Corporation	Calgary	403–236–2203	Calgary Hazardous Waste Storage and Transfer
11385	Pat's Off-Road Transport Ltd.	Medicine Hat	403–527–4774	Redcliff Hazardous Recyclable Storage
68686	RB Williams, Edmonton Processing	Edmonton	780–438–2183	Edmonton Hazardous Recycling/Industrial Waste
140	Safety Kleen Canada Inc.	Nisku	780–955–2788	Nisku Hazardous Waste Storage and Transfer
10111	Safety Kleen Canada Inc.	Calgary	403–243–3877	Calgary Hazardous Recyclable Storage and Transfer
9791	Smithbrook Waste Mgt Systems	Brooks	403–362–4905	Brooks Hazardous Waste Storage and Transfer
184498	Sumas Environmental Services Inc.	Nisku	780–955–2390	Nisku Hazardous Waste Facility
11531	Sumas Environmental Services Inc.	Big Valley	780–955–2390	Big Valley Waste Solidifi/calcifica/Fixation Plant
17929	The ECL Group of Companies, Tnkfrm	Edmonton	780–466–3030	Edmonton Recyclable Storage and Fuel Blending
1439	The Recycle Systems Company	Nisku	780–955–2508	Nisku Aerosol Recycling Plant
11614	University of Calgary	Calgary	403–220–6345	Calgary Haz. Waste and Recycl. Storage and Transfer
20370	University of Alberta	Ellerslie	780–492–5655	Ellerslie Waste Management
21004	Van Brabant Oil Ltd.	Morinville	780–939–5073	Morinville Waste Oils and Lube Filters
136612	Wasteco Environmental Services Ltd.	Edmonton	780–944–0057	Edmonton Container Washing Facility

The above information was current as of November 15, 2004. Changes since that date will be reflected in the listing provided by Alberta Environmental Protection at http://www3.gov.ab.ca/env/waste/indhaz/index.html. Click on *Alberta Facilities with an APEA approval* to bring up a current list.

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Appendix H

Consultants for WHMIS Training

Company Name	Address	Telephone Cellular Phone	Fax	E-Mail/Home Page
6-s Safety Services Tom & Rena Stewart	Box 376 Rocky Mountain House, AB T4T 1A3	403–845–7124	403–844–4191	
AMEC Earth & Environmental (Offices in Edmonton and Calgary)	4810–93 Street Edmonton, AB T6E 5M4 221–18th Street SW Calgary, AB T2E 6S5	780–436–2152 403–248–4331	780–435–8425 403–248–2188	Kevin.Schmidt@amec.com www.amec.com William.Lawson@amec.com
Anfel Mobile Health Services Inc.	1 Evans Place St. Albert, AB T8N 5N2	780–418–2679 780–717–1088		andyfel@telusplanet.net
Betker & Associates	1534 Evergreen Drive SW Calgary, AB T2Y 2X7	403–256–6212 403–660–0468	403–256–6215	
Brad's Complete First Aid Services Brad Melnichuk	9921–164 Street Edmonton, AB T5P 3R2	780–444–4229 780–995–4229		bradsfirstaid@shaw.ca
Breath for Life/Souffle de Vie	615 Henderson Street Edmonton, AB T6R 1S4	780–434–1368	780–430–7429	
CBA Contract Business Associates Inc.	RR 2, Station Main Olds, AB T4H 1P3	403–556–3109	403–556–7744	
Christie Communications Ltd.	Suite 530, 10909 Jasper Ave. Edmonton, AB T5J 3L9	780–424–4433	780–424–4888	
Contact Safety Sr. Ltd.	Box 1466 Stettler, AB	403–742–2035	403–742–2033	
D.R. Consulting and Repair	P.O. Box 221 Penhold, AB T0M 1R0	403–886–4180	403–342–3438	

These lists are provided as information. Inclusion in these lists DOES NOT imply recommendation by the Alberta Government.

Source: Occupational Health and Safety, Resource Directory of Consultants for WHMIS Training, April 2004.

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Appendix H (continued)

Company Name	Address	Telephone Cellular Phone	Fax	E-Mail/Home Page
Dalcom Industrial Health Consulting Inc. Contact: John Dallinger	P.O. Box 11831 Edmonton, AB T5J 3K9	780–464–9602	780–464–9602	
Deborah Smith & Associates	12217–25 Avenue Edmonton, AB T6J 4S7	780–430–9590	780–430–9549	Gadcbc2000@yahoo.ca
Decisive Safety Ltd. Bernhard Martens	9635-69A Street Edmonton, AB T6B 4V6	780–465–5859	780–465–5859	benmar@planet.eon.net www.planet.eon.net/-benmar/safety.html
Deerfoot Consulting Inc. Mike Phibbs, MBA, CIH, RCH	515 Parkvalley Road SE Calgary, AB T3E 4S2	403–512–0883	403–271–0916	mikc@deeffootconsulting.com
Environmental Health Professionals Ltd. (Offices in Calgary and Edmonton)	1944–10 Avenue SW Calgary, AB T3E 4S2 100, 11230–119 Street Edmonton, AB T5G 2X3	403–244–3233 780–413–6730	403–244–3234 780–413–6731	
FACT – First Aid and CPR Training	1–2021 Millbourne Road W Edmonton, AB T6K 2N4	780–448–2388	780–448–9630	info@fact.ab.ca www.fact.ab.ca
Flatline Response Inc.	5918–3rd Street SW Calgary, AB T2H 0H8	403–571–7655	403–571–7650	info@flatlineresponse.com www.flatlineresponse.com
G-com Consulting Ltd.	10061–166 Street Edmonton, AB T5P 4Y1	780–488–2325	780–480–3019	gcom@telusplanet.net
Gamer Associates Ltd. Occupational Health, Safety and Disability Management Services (Other locations: Edmonton, Red Deer, Grande Prairie, Medicine Hat, Lethbridge, Fort McMurray, Drayton Valley, Whitecourt)	#215, 2915–19 Street NE Calgary, AB T2E 7A2	1–888–345–4433	403–735–6125	

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Appendix H (continued)

Company Name	Address	Telephone Cellular Phone	Fax	E-Mail/Home Page
Guzzardi Associates OHC Inc.	58 Harvest Oak View SE Calgary, AB T3W 4Z5	403–226–3866	403–226–7205	
Industrial Safety International (ISI) Inc.	Bay #6 4101–19th Street NE Calgary, AB T2E 7C4	403–280–2888 1–888–689–8886	403–203–2881	
Kestrel Resources Ltd. • Walter (Wally) Cook • Davyn Longmore	39 Rivard Crescent Beaumont, AB T4X 1L6	780–929–5422	780–929–5454	
Leduc Safety Service Ltd.	1903–4th Street Nisku, AB T9E 7V2	780–955–3300	780–955–7651	
Levitt Machinery – Safety Training	6735–11th Street NE Calgary, AB T2E 7H9	866-291–0977	604–294–6818	safetyinfo@leavitt.ca www.leavittmachinery.ca
MJP Safety Consulting Services	122 Emerson Drive Hinton, AB T7V 1M3	780–865–4272	780–865–5174	
McAtee Safety and Environmental Health Services Ltd.	23 Parkwood Rise SE Calgary, AB T2J 2X7	403–271–9796	403–271–9796	
Mark One Safety Services Limited	Box 1114 Nisku, AB T4E 8A8	780–955–3885 1–888–296–2751	780–986–1653	
Mountain Industrial Supplies Inc.	244 B – River Avenue Box 127 Cochrane, AB T4C 1A4	403–932–9588	403–932–9217	
Nationwide Safety Management and Consulting	21, 4917–48 Street Red Deer, AB T4N 1S8	403–340–3056 1–877–399–0909	403–340–3438	nwsafety@telusplanet.net www.nwsafety.ca
NorQuest College	10215–108 Street Edmonton, AB T5J 1L6	780–415–2278	403–415–6123	

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Appendix H (continued)

Company Name	Address	Telephone Cellular Phone	Fax	E-Mail/Home Page
PHH Environmental Limited (offices in Calgary and Edmonton)	Suite 105 1144–29th Ave NE Calgary, AB T2E 7P1 Suite 200, 9707–110 Street Edmonton, AB T5K 2L9	403–250–5722 780–425–6600	403–291–0612 780–425–5126	
Phoenix Safety and Loss Control Inc.	15035–69 Street Edmonton, AB T5C 0J3	780–478–8621 780–719–0409		www.alberta-safely.com
Portage College	P.O. Box 417 Lac La Biche, AB T0A 2C0	780–623–5512	780–623–5816	Brenda.robitaille@portage.ab.ca
Progressive Hearing Services (offices in Calgary and Saskatoon)	#225,222–16th Ave. NE Calgary, AB T2E 1J8 #10, 2112 Ste. Cecilia Ave Saskatoon, Sk. S7M 0P2	403–230–0963	403–276–4995	
Pro-Train Fire and Safety Training & Consulting	Box 62 Irricana, AB T0M 1B0	403–819–3375	403–935–4404	lpeter@telusplanet.net
Pulse-8 Safety Consultants Inc.	78 Douglaswoods Way SE Calgary, AB T2Z 1M1	403–279–0013		
Purcell Enterprises Ltd. Barbara Semeniuk, BSc., CRSP President	2051 Tanner Wynd Edmonton, AB T6R 2R4	780–431–1284	780–431–1284	barb@firstbesae.com www.firstbesafe.com
RM Safely Services Inc.	81 Baird Street Red Deer, AB T4R 1H5	403–346–4436	403–346–4436	
Response Safely and Rescue Services Inc. Tracey R. Olfert	6502-12 Street NE Calgary, AB T2H 0G6	403–287–8578	403–287–8533	responsesafety@telus.net www.responsesafety.ca
S.E.A.L. International Ltd.	#500, 700–5th Ave SW Calgary, AB T2P 0T8	403–221–8077	403–221–8072	
St. John Ambulance	2905–12 Street NE Calgary, AB T2E 7J2	403–250–2922	403–250–3224	

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Appendix H (continued)

Company Name	Address	Telephone Cellular Phone	Fax	E-Mail/Home Page
Safety Excellence Inc.	16515 Sunhaven Road SE Calgary, AB T2X 2L7	403–803–0084	403–254–0767	dan@safetyexcellenceinc.com www.safetyexcellenceinc.com
Scotford Safety Inc./Mobile Testing Unit	11238–88 Avenue Fort Saskatchewan, AB T8L 3W5	780–998–2266	780–998–0954	Sales2@scotfordsafety.com
Skyway Canada Limited	3408–76 Avenue Edmonton, AB T6B 2N8	780–413–8007	780–413–8012	
Smith Safety Services	Box 46, Site 4 R.R. #2 Stony Plain, AB T7Z 1X2	780–975–1399	780–963–8334	
Strategic Safety Inc.	#308, 612, 500 Country Hills Blvd. NE Calgary, AB T3K 5K3	403–242–1994	403–242–1999	
TDG-WHMIS Compliance Centre Inc.	9320–49 Street Edmonton, AB T6B 2L7	780–461–2525 1–888–860–2068	780–469–0485	tdgwhmis@telusplanet.net www.tdgwhmis.com
Teck Safety Inc. Contact: Ken Black	14620–54 Street Edmonton, AB T5A 4L5	780–974–5054	780–475–0084	tecksafety@telus.net www.tecksafety.com
WHMIS Inc.	11412–102 Avenue NW Edmonton, AB T5K 0P9	780–488–7359	780–488–4901	
WJ Management Services Ltd.	4106–42 Street Red Deer, AB T4N 1B8	403–302–2829	403–309–5594	
Wisdom Consultants	3733–29 Street Edmonton, AB T6T 1H6	780–461–5907	780–461–5907	Cwisdom@compusmart.ab.ca
Workforce Development Grande Prairie Regional College	10726–106 Avenue Grande Prairie, AB T8V 4C4	780–539–2975	780–539–2791	workforce@gprc.ab.ca www.gprc.net

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